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總編輯 黃炎 總務 袁丕烈

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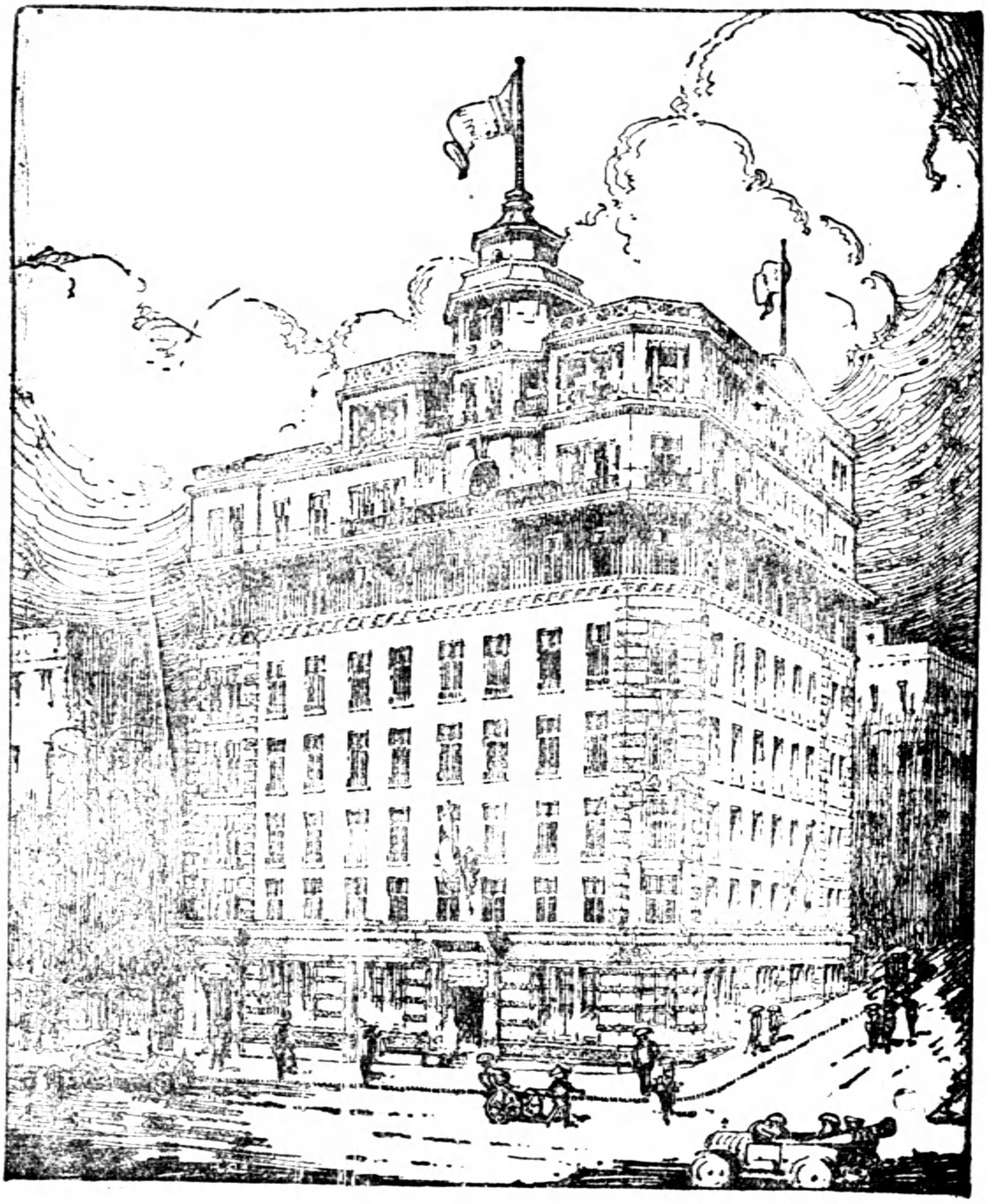

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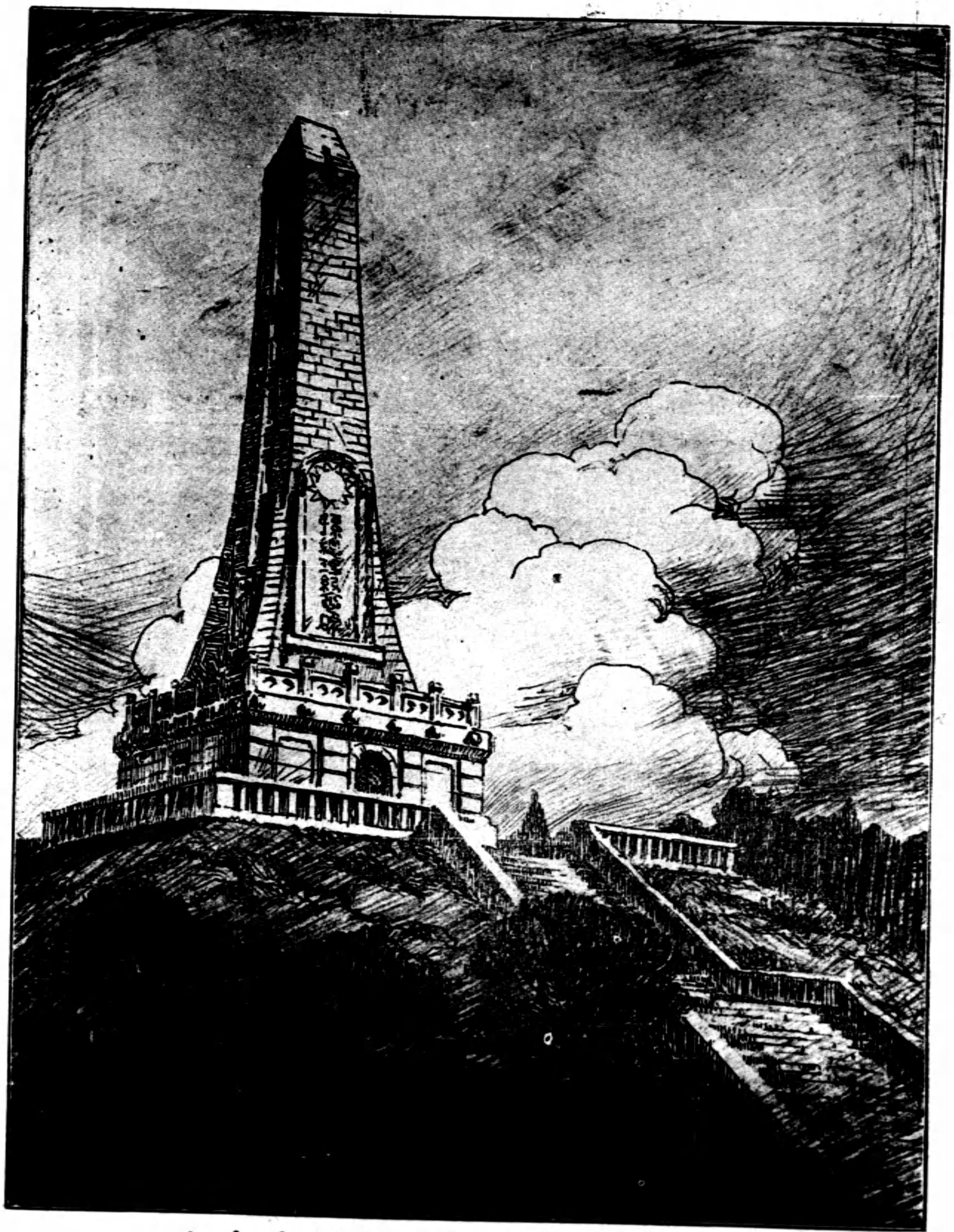

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室以公同好用將李先生玉照刋登以資紀念附誌數語聊伸謝悃

編輯引言

食水供給

食水供給爲工程師對於人類康健幸福之絕大供獻.吾國人飲食洗濯之所需,向取之附近之河,宅旁之井,或積貯天雨之水以爲之.既不便挈取,復以水源不潔,未經澄濾,易受疾病之傳染.近來城市居民,日漸增多,工藝製造,亦漸發展,故水供問題,遂爲社會人士所注意.據編者所聞,吾國大城市之急於興辦自來水者,有十餘處之多,梧州南京其較著者也.梧州處地雖僻,然年來建設,不遺餘力,自來水工程,已在建設中.讀本期所載凌鴻勛君之計劃及預算,可見一斑.南京亦亟從事進行,而先穿鑿自流井多處以救急需.本期有徐百揆君建築首都自流井之經過,詳述該處之地質,爲工程界頗有價值之貢獻.所以自來水建設,行將在工程上佔一重要之地位,而今代爲計劃籌措者,大多爲承辦機器之外商,甚望國人有急起組織以經營此項事業者.

電燈電力

西方物質文明之最足爲國人所歡迎者,厥惟電燈,而其興辦也,亦較他種事業本輕而利厚.故各處縣鎮,戶口在數千以上者,類皆能辦一電廠,燈光照耀,不復如往日之黑暗矣.然而電廠固多,其間辦理合法者,大有其人,內容腐敗者,十居八九焉.小者固無論矣,即通都大邑,若南京,若九江,似宜有新式之廠,明潔之燈.而考其實際,則大不然.電廠辦理之不善,其原因頗爲複雜.張延祥君本期之「南京電燈整理之成功及其方法」,及上兩期所載關於改良梧州,電廠各篇,對此均有所發明,頗堪借鑑.

橋梁工廠

鐵路建設,除軌道外,其費用以橋梁爲最巨,其關係甚鉅,亦極重要.吾國鐵

路上所有橋梁,悉由外洋定造,距今年代已久,負力不足,頻年戰爭,毀壞損傷,又不計其數.爲發展交通計,津浦漢平等幹路上橋梁之當加固修繕,大有不容稍緩者矣.此類工程,若一一須向外洋定造,曠日持久,不經濟孰甚.且一旦發生事故,工程緊急,而猶須賴外洋廠家,定製於數萬里之外,則緩不濟急,其害立見.邇來鐵道部特聘美顧問魏頡兒來華.漢平路上加固橋樑,建設橋樑工廠一處,爲其努力籌劃中之一.本期聶肇雲君「建設津浦鐵路橋梁工廠意見書」,尤稱及時之作.

市 政

吾國向來祇有市而無政.故市之繁盛,全恃地勢之衝要,出產之富庶,商賈之輻湊而成,一任其自然發展,而無人爲之作通盤籌劃以經營主持之者.故商務雖繁盛.而街衢仍湫隘,人烟雖稠密,而食水仍汚濁.內地各處市鎭,大率皆然,不僅蕪湖一埠如是也.張連科君「蕪湖市政問題之考察」,所舉各條,頗簡明切實,登載本期,以質當世.

鐵 路 橋 工

吾人今日所有之技術經驗,所用之材料工具,均較數十年前豐富精確,強固便利.故今日工程專家所能舉辦者,較向時偉大迅速,有把握而無危險.此皆由前人經歷其事之時,費盡無限腦力光陰,以索得良善之方法,解決當時之困難.及其事成之後,又不憚煩瑣將親歷所得,一一筆之於書,傳佈於世,以供參證與研究.積之既久,學術愈新經驗愈富,而人類之幸福,亦因之而進矣.本會劉峻峰君主持柳江橋墩工程,今將其所經歷者,不論巨細,一一紀錄之,著成長篇,囑本刊付印.劉君之作,不僅本刊增多有價值之材料,即全國工程界,亦增添不易覓得之參考書,殊可貴也.

機 車 修 理

吾人在求學時代,往往注重於學理及機械重要部份之名稱部位,而對於

一枝一節微細之處,則一概忽之.及出而任事,則對於各種 Detail, 始逐漸加以注意.及至老於其事,則於大綱節目,反不甚經意.而專對於一枝一葉極微甚小之處,則反覆深思,層層考慮焉.此無他,身體爲髮膚之積,機械爲小件之積,小件之緊要,固無異於大體也.張蔭煊君著「機車鍋爐之修理」,分載上期及本期.敍述學理經驗,細大不捐,是爲趨重 Detail 之文.

無線電

無線電之建設,近年來頗能積極進行,成績良佳.讀本期錢鳳章君「建造梧州無線電台記」,電台內部之情形,可見一斑.吾國無線電今既有若是成績,將來發展,更多希望.惟事業之發達,與學術之進步,不能分離.若欲學術進步,則又賴乎共同努力探討研究.朱其清君「徵求無線電界同志合作啓」一篇,刋本期後,閱者必有以賜教焉.

烏桕子及其產物

以上所述各項新事物,如清潔之水,光明之燈,完善之市政,平寬之道路,長橋如虹,電線如網,無一不爲吾人所樂有,無一不爲現代之人所宜有,且無一不爲吾工程界人士所悉心經營者.然而此新事業所需之原料,所用之機器,大都來自外洋.於是新事業愈發達,外來貨物愈充斥,吾人將何以善其後.是以一方面採用西方學術以發展各業,同時尤須研究國有物產,加以改良,銳意推銷於海外,以有易無,方不匱乏.烏桕子 Stillingia Sebifera 爲吾國特產之一,用途甚廣,製造油漆,功用尤著.早已風行世界,成國際之貿易品.沈熊慶錢嘉集二君,詳加化驗,幷示種種改良之方法,此誠當今之急務也.

黃河

黃河爲患,史不絕書,生命財產之喪失於是者,何可勝計.惟工程浩大,民生窮促雖明知其險急,而亦無可奈何.雖然,黃之不治,國家之憂,今雖無力,固未

可淡然置之也.鄭肇經君譯「制取黃河論」,附有圖表,爲他處所不經見.列入本期,以供參閱.

機器製造

費福熹君「瑞士卜郎比製造廠之略述」篇,能與吾人不少奮興與感歎之處.瑞士爲蕞爾小國,有若斯巨大之製造廠,推銷其出品於全球而至吾國,一也.歷時僅三十八年,自七十人工作之小廠,逐步推廣,而成今日完備之規模,二也.吾國地大物博,百業未興,方之歐州,彷彿卜郎比未成立以前之光景,而前途之寬廣,希望之遠大,則又過之.吾國其亦有白郎樸萬里其人乎!用汝心思,竭汝才力,師彼堅苦卓絕耐久勤進之精神.則卜郎比廠之實現於吾國,亦非不可能者矣.

本刊

本刊發行,至今完成四卷,雖無多大成績,可供稱述.却也經過若干變更,若干改良,而至今日之情形.篇幅增多,內容較富,一也.材料漸趨實用,多圖繪照片表册,不復徒托空言,二也.改良紙張及印刷,清淅悅目,價值倍增,三也.銷數推廣,廣告加多,使本刊能自身維持其生命,而免本會經濟上之負擔,四也.竭力注重時日,以求按期出版,確守信用,而免延誤之愆,五也.凡此均本會多數會員共同合作之成功,亦本會進取精神表現之一點.惟本刊至今,尚極幼稚,不過稍具專門刊物之粗形,而其精采身份,一與西洋刊物較相去何可以道里計.是以進步改良,奮勇直前,尤須密密加工,刻不容緩.敬望閱者諸君,無論其爲本會會員抑非會員,常賜協助,或撰著文稿,或擔任編輯,或推廣銷數,或介紹廣告,或作事務上之幫忙,或與精神上之指示,不論巨細,均所歡迎,地無遠近,均可合作,同志諸君,不吝賜教.

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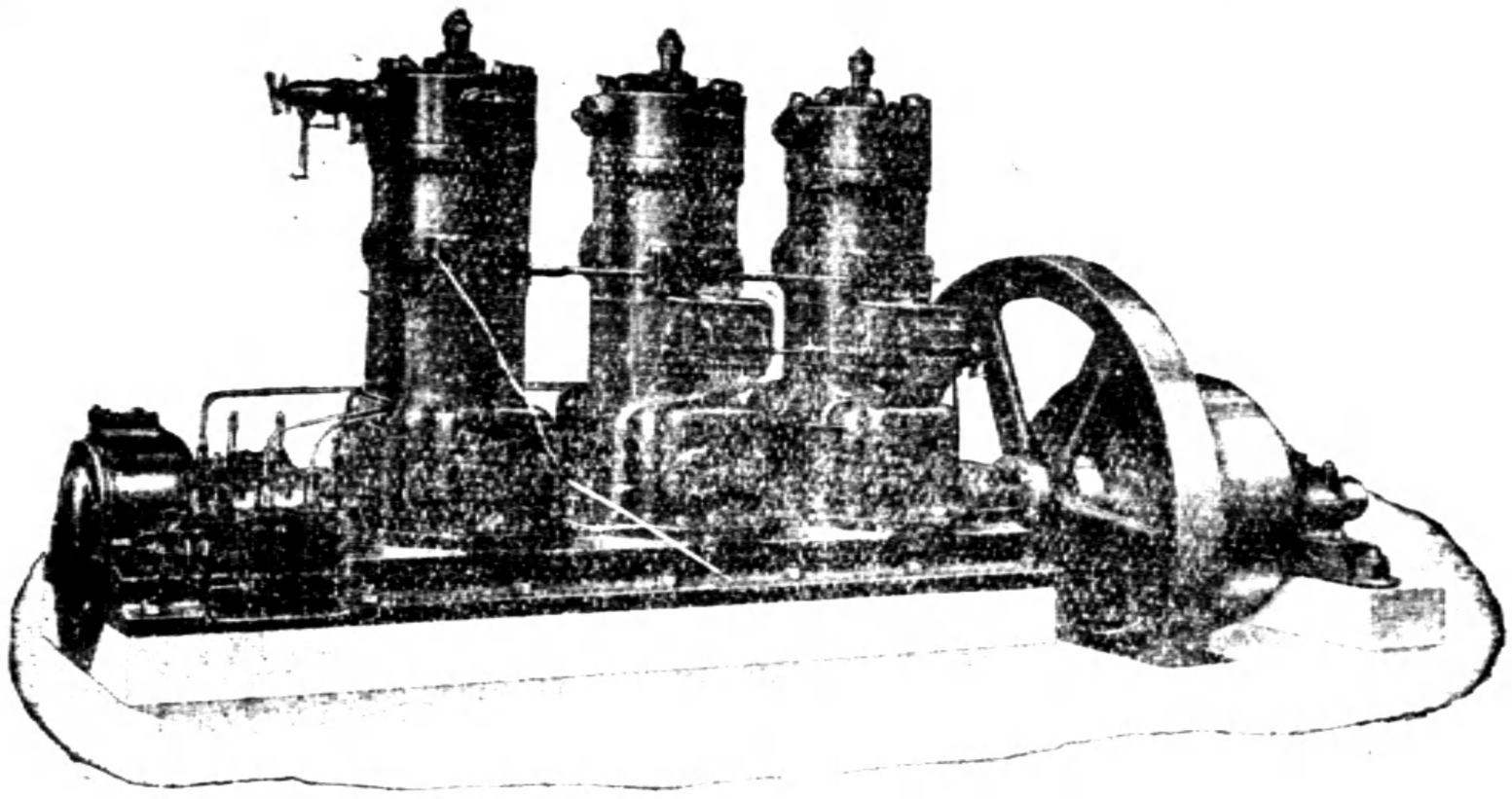
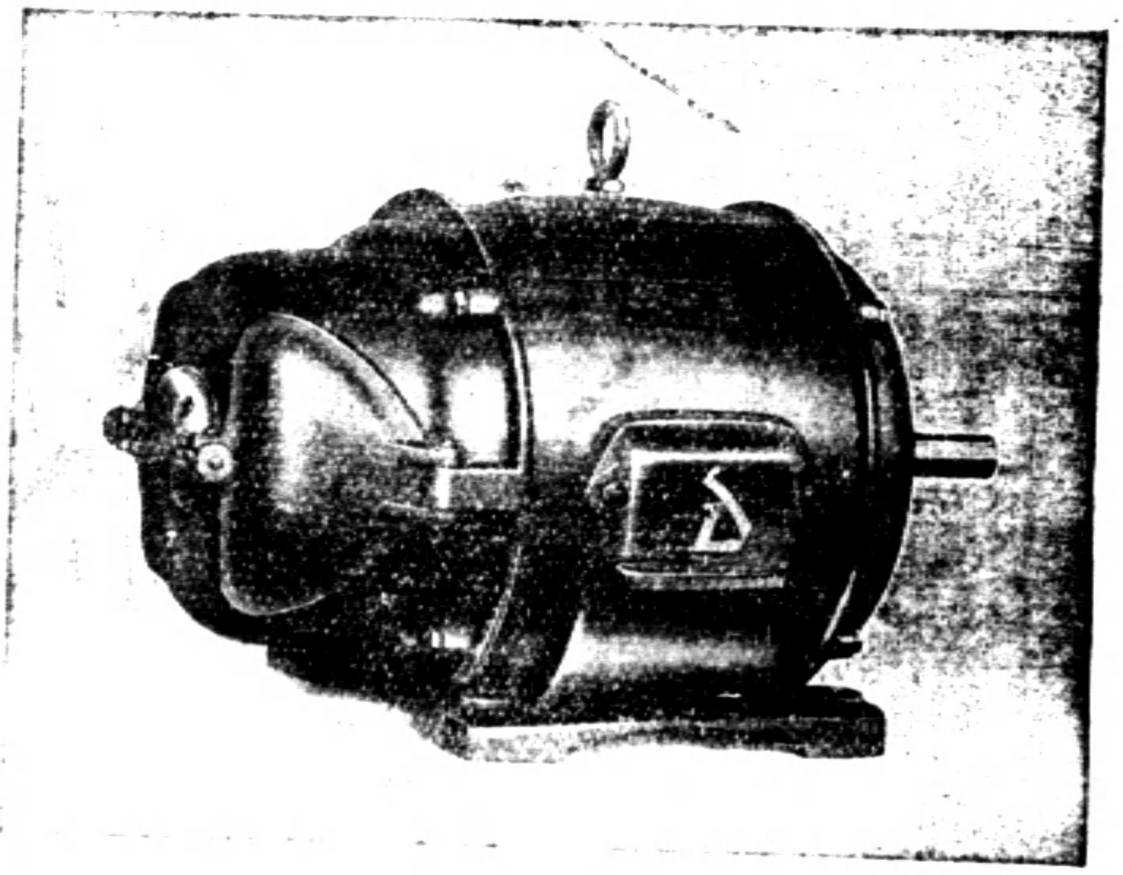
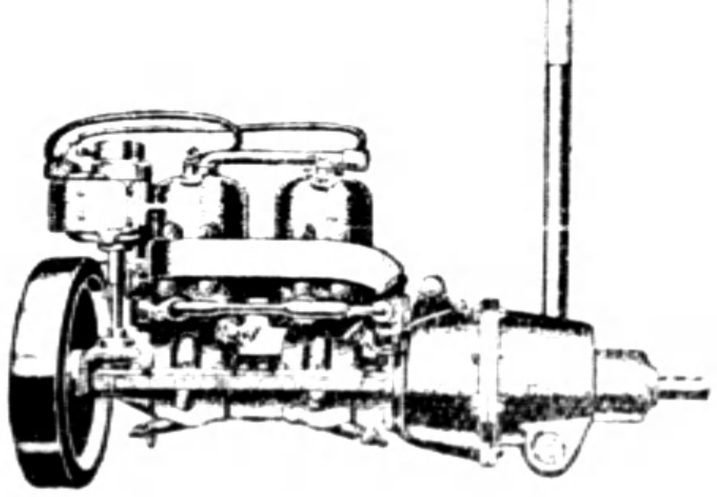


德國突起廠造最新式無壓氣地實爾柴油引擎構造堅固用油節省經濟便利遠勝他種岸用船用俱備



敝行備有大批電氣馬達價格低廉工作耐久馬力大小俱有



更備有象牌洋油引擎包捷克廠造離心力抽水幫浦捷助牌輕便救火機器龍魚磨麵粉機包捷克冷藏機器及滾路機器等種類繁多恕不備述如荷垂詢當即詳細報奉以答高誼

漢口特別一區二碼頭江邊三號

烈

梧州市自來水供給計劃及預算

著者：凌鴻勛

緣　起

梧州市食水之困難　梧州市舊有井泉甚少,市民食水以取自大河,（即西江）撫河,及冰井,三處爲多.大河之水,常年混濁,由上游帶下之泥土雜質甚多.撫河之水,每歲約有三四十日混濁,其餘則頗清潔.冰井冲之水,則較之河水爲清.市民取水,每以地之遠近,爲選擇水源之標準,而於水之潔淨與否,絕不注意.每屆冬令,河水乾涸,水面較之河邊馬路低落五十餘呎,婦孺肩挑上下,至感困難.而取水時祇能挑取靠近岸邊之水,水流較爲停滯,沙泥穢物挾帶至夥.冰井冲至冬季水源亦枯竭不敷應用,挑取亦至困難.夏令河水陡漲,通常水汛高出河邊馬路約十呎.民國四年,大汛高出近三十呎,城市半淹於水,居民就地取水作飲料,污濁情形,尤難筆述.梧市市民處此情形之下,食水至爲不潔,供給尤感困難,水費負擔至重.他如身體之不能有相當之洗浴,衣服之不能有充分之濯滌,間接影響於生活之愉快,更不待言矣.

梧州火患之危險　梧市取水之困難,既如上述.每屆天高物燥,火警至屬堪虞.民十三年,九坊五坊諸街大火,全市精華幾盡付一炬,梧人至今譚之色變.年來馬路多已開闢,而層樓高聳,市房繁密.冬令河水低落,每遇火患無從挽救,市民生命財產,祇可一付天命,言之實足驚心動魄也.

梧市供給自來水之容易　凡一市建設自來水之難易,當視水源之遠近,及質地水量等主要問題而定.他如地理上之情形,與城市發展之狀況,均與供水計劃至有關係.譬如上海閘北水電廠水源取自吳淞,離閘北約二十四華里,總管費用近百萬元.又如廈門自來水因瀕海之故,須建築極大水塘以蓄雨水,因之水廠全部工程較爲浩大.梧市撫河之水,頗爲清潔,離市區至近,

而不至爲市區所污濁.河邊有山,山上有平地可以建池,抽水入池,即可分佈全市,而市區範圍又狹窄,故梧市自來水供給之經營,在工程上比較容易,在經濟上因之較爲易舉.

梧市自來水宜市辦或宜商辦　自來水爲公用事業之一,一方以利便市民改進生活爲目的,一方亦爲一生利之事業.在我國則公營商營兩例具在,與電力廠較,則水廠之生利較之電廠爲緩,爲利亦較微,而成本則較大,故本國城市有電燈者已多,而有自來水者則僅少數也.以梧州而論,商辦電力公司成績不著,改歸市辦後結果至爲美滿.加以自來水之抽水機,倘另行設機發動,成本更高,若用電力廠電力發動,則電費一項爲常年經費一大宗,(照梧州情形,水廠如用電力發動,每年須付電廠之電費,照電廠定價付給,約居全年支出百分之六十).負擔亦重.今梧市電廠既係市辦,若水廠亦由市辦,則所用電力同係出自公家,可以照本收費,其他人員及設備,均可互通.加以水廠三四年內難期生利,由市經營則贏縮易於調劑,水廠資本較大,商辦一時不易號召,故以市辦爲較宜也.

市府創辦自來水之決定　梧市自來水之需要既亟,而公營又有種種便利,故梧州市政府已決定由市創辦.市工務局業於十七年夏間,開始測量取水及水塘地點,水管分配,並調查各街道用戶多少,及水量情形.茲已將全部計劃完成,將於年內開始動工,明年年內當有清水之供給.市府既爲便民起見,將來對於水費務求低廉,並擬於貧民住居區域,設置公共售水站,俾市民都能享受自來水之利益,而工務局方面對於市民之裝用,亦務期手續迅速佈置周全,則又可預爲市民告者也.

計劃

水量　一市之供水計劃,應有若干之供水量爲一最關重要之問題.計劃過大則資本鉅而收利微,計劃過小則無以應城市將來之發展,將有供不應求之苦.故欲決定一市供水之多寡,當先研究一市現在之人口,歷年人口增

進之統計,將來人口增加之趨勢,工業之發達,市政之進展,以及社會一般之情況,方能得一較適當之結果.今試將自來水之用途而分析之.(一)家庭用水.如飲食,洗浴,洗衣,洒掃等之類,此項用水固與人口爲正比例,亦視社會之文明程度,與經濟狀況而異.譬如地方較開通者,人民咸知洗浴,滌衣,洒掃之必要,且多有水廁之設備,家庭內之用水必較多,用戶亦必增加,卽常人平日感受取水之難,水費之貴,今有廉價之清水,取之又便,每家每日所用之量,自難與昔日河中挑水時代一律觀察.(二)工業用水,此項水量視工業之發達情形而異,如工廠衆多或爲鐵路終站,則用水必較之工業不盛之地爲多,礙難得一平均之數目.(三)市政用水.此項當視市政之建設情形而異,如馬路廣闊常須洒水,或園林茂盛常須灌水,或市場所在常須冲洗,則耗水較多,數量亦略視地方之氣候而異,而同一地方之數量,亦視節候而不同.(四)消防用水.此項殊難預計,無論何處城市,不能不有所預防,其數量及需用之時間均無從預定也.以上四者,各處情形不同,爲便利起見,亦多按人口計算,以每人每日用水若干爲標準,而依其地方情形於(二)(三)兩項增加或減少之.英美兩國都以英國加侖 Imperial Gallon 爲量水標準.(每加侖約合四公升半重約十磅).我國茲已頒行萬國公制,故梧州今後量水當以新制爲標準.

梧州市人口,據梧州市公安局民國十七年十一月公佈調查之結果,連三角嘴一帶及水上結筏而居者,共計一萬五千餘戶,人數八萬九千九百餘人.在一,二,三,三警區範圍內,爲目前自來水供給所能及者,計約六萬三千餘人,而此六萬三千餘人之中,其居瀕撫大兩河之濱者,必有一部分因挑水之便利.不裝用自來水,而其他或有因經濟關係不裝用自來水者,故目前用水之戶口,爲數當不逾六萬人.又據工務局十七年秋間對於市民用水之調查,就所得之報告,每人每日用水約一桶至一桶半.(每桶爲量四加侖,重約三十斤,是每人每日用四加侖至六加侖,重自三十斤至四十五斤也).然前項報告多來自用水較多之戶,其貧戶未經填報者,平均之數必較低.惟梧市工商

業日臻茂盛,人口亦與俱進,計劃之始不容不略爲寬放.故茲次計劃係預計目前用水人口爲八萬人,每人平均每日用水六十五公升.(約合十四加倫半,重約一百零八斤),並預計二十年後用水之戶,增至十二萬人,故目前設計,係以十二萬人計,每日水廠出水七千八百立方公尺,卽七千八百公噸,平均計算每小時須出水三百二十五公噸,但日間用水較之夜間爲多,今假定最多之一小時內所用水爲平均數目之一倍,卽六百五十公噸,今設同樣之抽水機二副,每副每小時能出水三百六十公噸,每機分兩班開駛十二小時,卽足敷一日之用,或遇一機修理,其他一機全日行駛,足以應付.倘二十年後人口果增至十二萬以上,則抽水塔地位,抽水機抽量,濾水池地位,皆已留有擴充一倍之餘地,將來供給二十四萬市民之用水,非難事也.

水源 大河撫河冰井三處水質,曾經化學之分析,其平均之結果如下:

梧州水質試驗表

驗水種類	大河水濾過後試驗者	撫河水濾過後試驗者	冰井冲水以原水試驗者
色度	微濁	無色透明	無色透明
臭味	無	無	無
反應	中性	中性	中性
綠氣	10.65 公絲	10.13 公絲	8.05 公絲
硫酸	0.982 公絲	0.534 公絲	無
硝酸	1.086 公絲	1.064 公絲	無
亞硝酸	0.00014 公絲	0.00013 公絲	無
安母尼亞	0.00163 公絲	0.00025 公絲	無
硬度	15.937 度	14.82 度	14.2 度
固形物總量	31.84 公絲	13.85 公絲	12.76 公絲
過錳酸加里消費量	10.24 公絲	10.64 公絲	10.5 公絲
細菌聚落數	約三百以上	約三百以上	約二百以上
試水回數之平均	五十回	三十二回	十五回

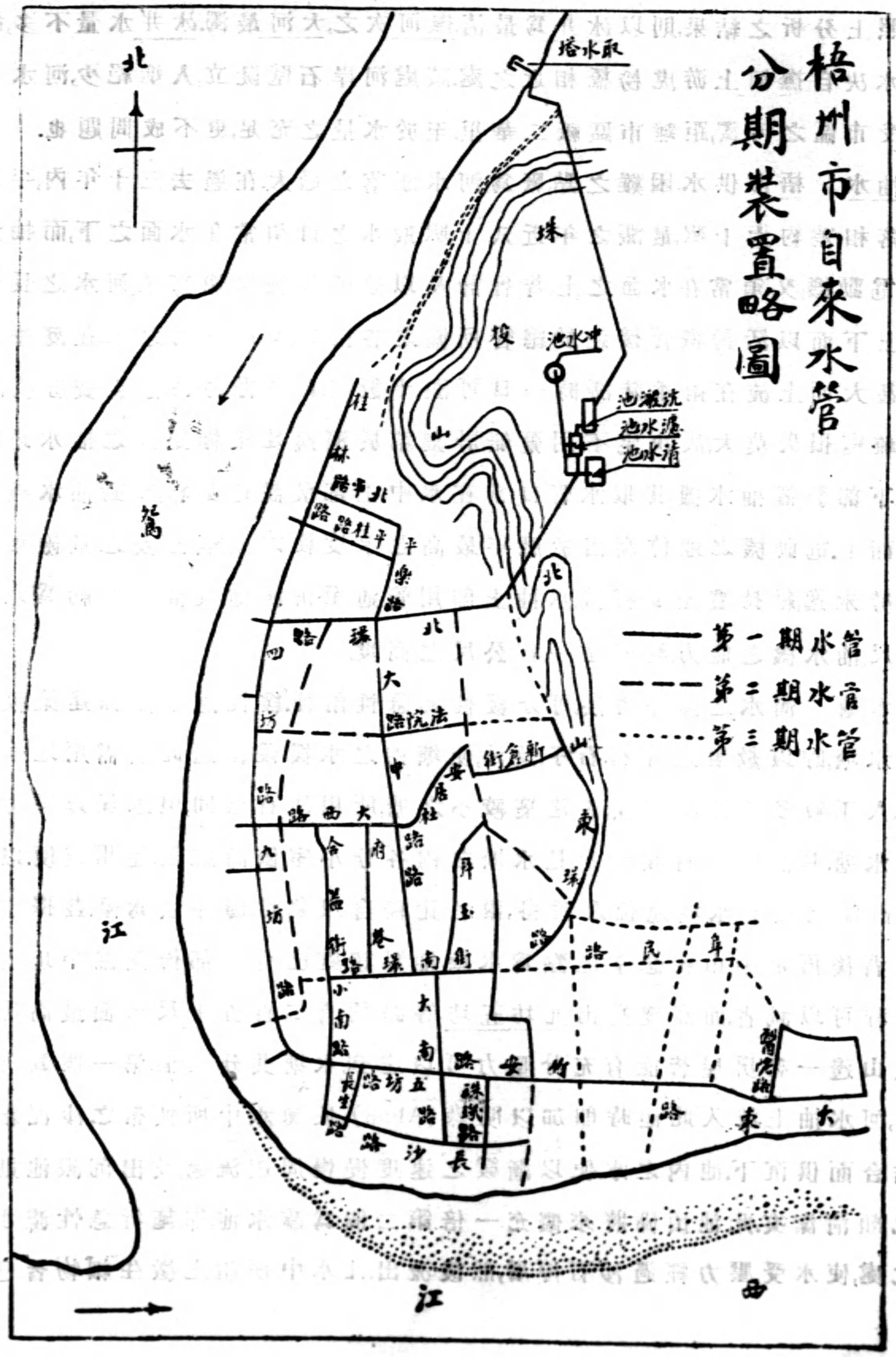
備考 每次試驗之水量爲一公升

照上分析之結果,則以冰井爲最清,撫河次之,大河最濁.冰井水量不多,故取水决自撫河上游虎榜橋相近之處.該處河岸石壁陡立,人烟絕少,河水不至受市區之汚濁,距離市區祇二華里.至於水量之充足,更不成問題也.

抽水　梧市供水困難之點,厥爲河水漲落之過大.在過去三十年內,平均漲落相差約六十呎,最漲之年近八十呎.取水之口須常在水面之下,而抽水之電動機,又須常在水面之上,昔曾計及以躉船作機房,俾可依河水之長落而上下,而以活動鐵管接連於總管所備之各接口.但以撫河之水,在夏季速度甚大,而上流在雨季陡漲時,一日可漲十數呎,日常提防注意,至費經營,萬一疏虞,損失莫大.故决定不用躉船計劃,第於河邊建築極堅固之抽水塔一座,下部裝置抽水機,其取水管口常在水中,上部裝設電動機,轉動抽水機,抽水而上.電動機之地位,高出於歷年最高之水度,使之永無淹及之危險,如此一勞永逸,維持費至爲輕減.水抽上即用管通至沉澱池,其間距離約爲六百公尺,抽水機之能力,約能達一百公尺之高度.

水塘　河水之濾淨方法,可分緩性與急性兩種.緩性濾淨法,係建築較大之水塘,貯以數層之碎石,石子,及沙,使塘內之水緩緩濾過,此法需用地面較廣,人工較多.急性濾淨法,係建築較小之塘,所用沙石略同,但水係以壓力經過水塘,其濾淨之時間較短,且水塘之內各分小室,依時啟閉,運用靈便.以梧市市區之狹窄,水塘地位之難得,兩者比較自以急性濾淨法爲優.茲擇定北山背後舊定中山紀念堂地點爲水塘地點,該處已有一部份開掘平坦,土方工程可以減省,而高度高出九坊五坊等路約有二百五十尺,市面最高房屋及山邊一帶房屋,皆能有充分壓力可以達到.水塘共分三個:第一個爲沉澱池,河水抽上流入此池時即加以明礬(Alum),使與水中所挾帶之沙泥雜質結合而俱沉下.池內之水使以漸緩之速度慢慢周迴流過,及出沉澱池則水已頗清潔矣.此池預備將來擴充一倍.第二個爲濾水池,即施行急性濾水法之處,使水受壓力經過沙石厚層,然後流出.凡水中所帶之微生細物皆已濾

梧州市自來水管分期裝置略圖



第一期水管
第二期水管
第三期水管

淨.此池亦預備將來擴充一倍;第三個爲清水池,即接受濾水池所流出之清水,貯以待用者也.由此即接連總管,再以分管分佈市區.

水管分配　河水自抽水塔抽上後,即以四公寸（十六英寸）之總管接至水塘,復由水塘以同樣之水管接入市區.市區內之分管,最大者爲三公寸,(十二英寸)最小者爲一公寸.(四英寸)附圖示市區內水管埋設於各街道之情形.其所謂第一第二第三期之分,乃係一時所預定,其中先後當臨時體察情形再行決定也.

水鏢　各都市收取水費,有照水鏢計者,有照人口或房屋間數計者.近來多趨重於照水鏢計算,蓋以付費照所用之水量計算,其辦法至爲正當.在用戶欲圖省費,可減省無謂之虛耗,而不至隨意耗用,而在水廠方面,則出水多寡有所稽核,兩感便利.故將來梧州市供水,一照電廠辦法概行裝鏢.用戶一次繳納按櫃若干,以後即按月照鏢付費,至於按櫃之多寡容後酌定.

公共售水站　市民用水,自以裝設水管於室內爲便.但市府爲便利貧民,使咸享清水利益起見,當於貧戶區域一帶,設置公共售水站,以低於成本之水價售於貧民.至於售水站之多寡及其地點,容後定之.

救火水龍　爲消防起見當於每路上設置救火水龍.俾消防隊得以隨處啓用.至於水平較低之馬路,夏季爲水潦所淹沒時,或先在地面上駁接水龍,或用救火電船就地抽水滅火當兼用之.

預　算

建設預算　梧市水廠建設費一部分已詢得確價,一部分祇能估算,因小洋兌換時有上下,今悉以港銀爲標準.

梧州市自來水建設經費預算

(甲)機械及電機設備	
1, 抽水機及電動機	港銀 22,000 元
2, 冲水池抽水機	1,400
3, 化學物料調和機	1,290
4, 綠氣機	3,380
5, 量水設備	7,200
	港銀 35,270 元
(乙)建築工程	
1, 取水塔	港銀 10,000 元
2, 沉澱池	25,000
3, 濾水池	40,000
4, 冲水池	3,000
5, 清水池	42,000
6, 辦公室	10,000
	港銀 130,000 元
(丙)水管工程(第一期)	
1, 水 管	港銀 65,182 元
2, 附 件	37,008
3, 水 鏢	17,660
4, 水管裝置	19,230
	港銀 139,080 元
(丁)由港至梧運費	港銀 15,000 元
(戊)關稅 7.5%	14,634 元
(己)建築時期內之工程費用	11,200 元
全部資本	港銀 342,184 元

經常預算 下表所列每年經常預算,係指第一期全部份裝置及使用而言.若僅一部份使用則電費一項當可比較省節.他如職工薪水,機械修理等,所省無幾.利息折舊不能節省.故出水愈多水價成本愈廉,(詳見營業預算)至於所開電費係照電廠發電成本計算.

梧州市自來水廠每年經常預算

全部分水量

1, 職員工役薪水		港銀 21,600	元
2, 電　　費		81,100	元
3, 修理及油料		15,000	元
4, 沉澱池及化學物料		11,000	元
5, 資本利息及折舊(15%)		51,300	元
	每年	港銀 180,000	元

以上係全部分水量計算

如發四分之三水量	(常年經費約爲)	港銀 150,000	元
如發二分之一水量	〃　〃	125,000	元
如發四分之一水量	〃　〃	95,000	元

售水預算　水廠出水量全數爲每日七千八百立方公尺,即七千八百公噸,內除四分之一爲公用,十分之一爲消耗,計每日可售出之水,爲五千零七十立方公尺,即五千零七十公噸,每年以三百六十五日計,可出水一百八十五萬立方公尺或公噸.

水價　各處城市所收水價,視公營私營及成本之大小而不同.其計算法有以鏢計者,有以戶計者.其用鏢計者多以每一千加侖爲單位.(每千加侖約重一萬磅,即七千五百斤).政府現已公佈統一權度制,水量應以每立方公尺即每公噸爲單位.(每一立方公尺合二百二十加侖),今將各處城市水價表列於後以資比較.(表附於570頁)

依上統計,每公噸水價廉者爲大一角一分,貴者爲大洋五角五分.梧市規模較小,成本較重,所收水價假定爲每公噸收價港銀一角七分,(照現時兌換率約合桂小洋三角二分,與電廠每度電費之數同,每公噸合二千二百磅,即一千六百五十斤),則水廠之營業預算如左:

地別	每千加侖水價	折合每立方公尺水價
上海閘北	大洋五角三分	大洋一角一分七厘
上海南市	五角	一角一分
上海租界	五角	一角一分
上海法界	五角五分	一角二分一厘
天津	七角五分	一角六分五厘
天津英界	一元	二角二分
漢口	一元	二角二分
廈門	二元五角	五角五分
廣州	東毫七角五分	東毫一角六分五厘
香港	港銀七角五分	港銀一角六分五厘
九龍	港銀七角五分	港銀一角六分五厘
北平		
汕頭		

營業預算 今將水廠出水量分爲四期計算;第一期出水四分之一,第二期出水二分之一,第三期出水四分之三,第四期全量出水.依此四時期之成本,售價及贏虧,預算表列於左,以醒眉目:

梧州市自來水廠營業預算

出水量	每年出水	成本			水價			每年贏虧	
	立方公尺	每立方公尺		每千加侖	每立方公尺		每千加侖		
		港銀	梧銀	港銀	港銀	梧銀	港銀	港銀(元)	梧銀(元)
¼	462,500	.20	.37	.93	.17	.32	.77	虧 13,875	虧 23,125
½	925,000	.14	.26	.61	.17	.32	.77	贏 27,750	贏 51,273
¾	1,387,500	.11	.21	.50	.17	.32	.77	贏 83,250	贏 125,625
全量	1,850,000	.10	.18	.45	.14	.25	.64	贏 74,000	贏 133,200

依上計算,如用水量祇及¼,則每年經費不敷港銀一萬三千餘元,如係暫時情形當無問題,否則或於水價略爲加增,以資彌補.第以梧市人口之稠密,初期裝用諒即可達到四分一之數,倘略爲高出四分一之水量則收支即可相抵也.

建設津浦鐵路橋梁工廠意見書

著者：聶肇靈

(一) 緒言

鐵路建設費,除軌道一款外,以橋梁爲最大,且其關係運務亦甚重要.無論橋梁跨度長短,其最要目的,爲保持行車安全,繼續運輸任務.茲據津浦鐵路史料所載,本路橋梁涵洞之座數,總長,及造價等,列爲第一表如下:

第一表　津浦橋梁涵洞表

橋洞稱類	座數	總長(公尺)	造價(銀幣)	平均每公尺造價
橋	378	14,499.40	14,804,430.40	1021.04
石橋	1290	8,098.00	6,134,556.75	757.54
涵洞	371	550.70	362,673.07	658.75
總計	2048	23,148.10	21,301,660.22	920.63

又據十三年交通部國有鐵路統計報告,津浦路路線及設備品之原價爲119,716,583.72元;則橋洞之資產,約合全資產百分之十八.又按鐵路工程與修養叢書所述,美國鐵路幹線橋梁之修養年費,由經驗上假定,平均約合橋梁原價百分之一·五;則津浦路每年修養橋梁應有三十二萬元之支出.查十三年份津浦工務維持費爲1,827,691.01元,占營業用款總數百分之十八·八.但第五項第四目橋工之支出以舊總局案卷被焚,無從查攷.如以美國假定爲據,則橋工修養費約占工務維持費百分之十七·五.準此則知橋工亦爲養路重要條款之一,吾人不容忽視者也.

美國北太平洋鐵路,於一九零三年判定,一千輛機車之服務該路者,平均不過十零·四 (10.4) 年.如以上述機車爲代表,則機車最長壽命可認爲二零·八 (20.8) 年.其意即爲每隔二十一年,所有機車概須換新.如機車之重

量增加,則每二十一年後,所有橋梁亦須加固增強,以資負荷較大之載重.茲舉美國鋼橋十座,實際上服務之時期列爲第二表如下:

第二表　鋼橋服務年限表

	路　名	橋梁所在地	建造年代	改造年代	壽年
1	C. M. & St. P.	Rock River	1884	1903	19
2	Wabash	Sangamon River	1885	1906	21
3	C. B. & Q.	Big Rock Creek	1881	1903	22
4	Ill. Central	Big Muddy River	1889	1902	13
5	Ill. Central	Tennessee River	1888	1905	17
6	C. & N. W.	Kinnikinnic River	1880	1909	19
7	P. M.	St. Joseph River	1881	1904	17
8	Grand Trunk	Niagara River	1887	1906	19
9	C. M. & St. P.	Menominee River	1886	1903	17
10	C. R. R. of N. Y.	Newark Bag	1887	1904	17

鋼橋本視爲永久的建築物,但照第二表所載,頗不盡然.其年壽之限制,係因載重之增加,而非因材料之磨損其改造之年限,各路微有不同,因其運輸之密度,機車之輪重,列車之載重,及行車速度等之差別而定其建築物之能否負荷.如第二表所示,各橋平均壽命爲十八•一年,內有七種相差不過二年.於此可知鐵路橋梁,在普通情形下,不過維持二十餘年之久.是改造計劃,須與修養工事並重.查津浦橋梁自建造迄今,將屆二十年;即無其他關係,亦應亟謀改造,以期適應運務之發達也.

(二) 津浦橋梁之概況

津浦橋梁涵洞之數目,已如第一表所載.其間津韓段橋梁爲德國承造,韓浦段橋梁爲英國承造;後者多爲鈑梁橋,尙能維持現狀;前者就核算及試驗之結果,審查該項橋梁,用以行駛美式機車,頗有危險之虞.查該段鋼橋,自十公尺平鈑橋,以至四十五公尺之構桁橋,皆係照德國規律設計;德式機車,衝

擊力不大,故設計橋梁之標準,祇以跨度之長短,定鋼料安全力之多少;不另加衝擊力,而衝擊力已包括在內,然爲數甚微.而美國設計橋梁之標準,鋼料安全力定爲每英方吋一萬六千磅所負之重量,另加衝擊力.交通部採用美法規定衝擊力公式如下, $I = S\frac{2,800}{2,800+L}$ ($I=S\frac{30,000}{30,000+L'}$, L' 以呎計). 上式I爲衝擊應力,S爲活重應力,L爲橋身荷重之長度.其衝擊力係數,可至百分之百.爲數甚大,因美式機車衝擊力較大故也.肇靈前在工程股時,曾用美國規律核算本路各式橋梁之強弱;就中以三十公尺開頂橋爲最弱.其結果如第三表所示.梁桿之載重,竟有僅至古柏式 E 類二十四號者;而本路美式機車行駛各種跨度上之重率,均超過 E 額三十五號,如第四表所示;足徵原有建築物之薄弱,不足負此重率,此就核算方面本路鋼橋已生疑問者一.

第四表　津浦美式機車重率表

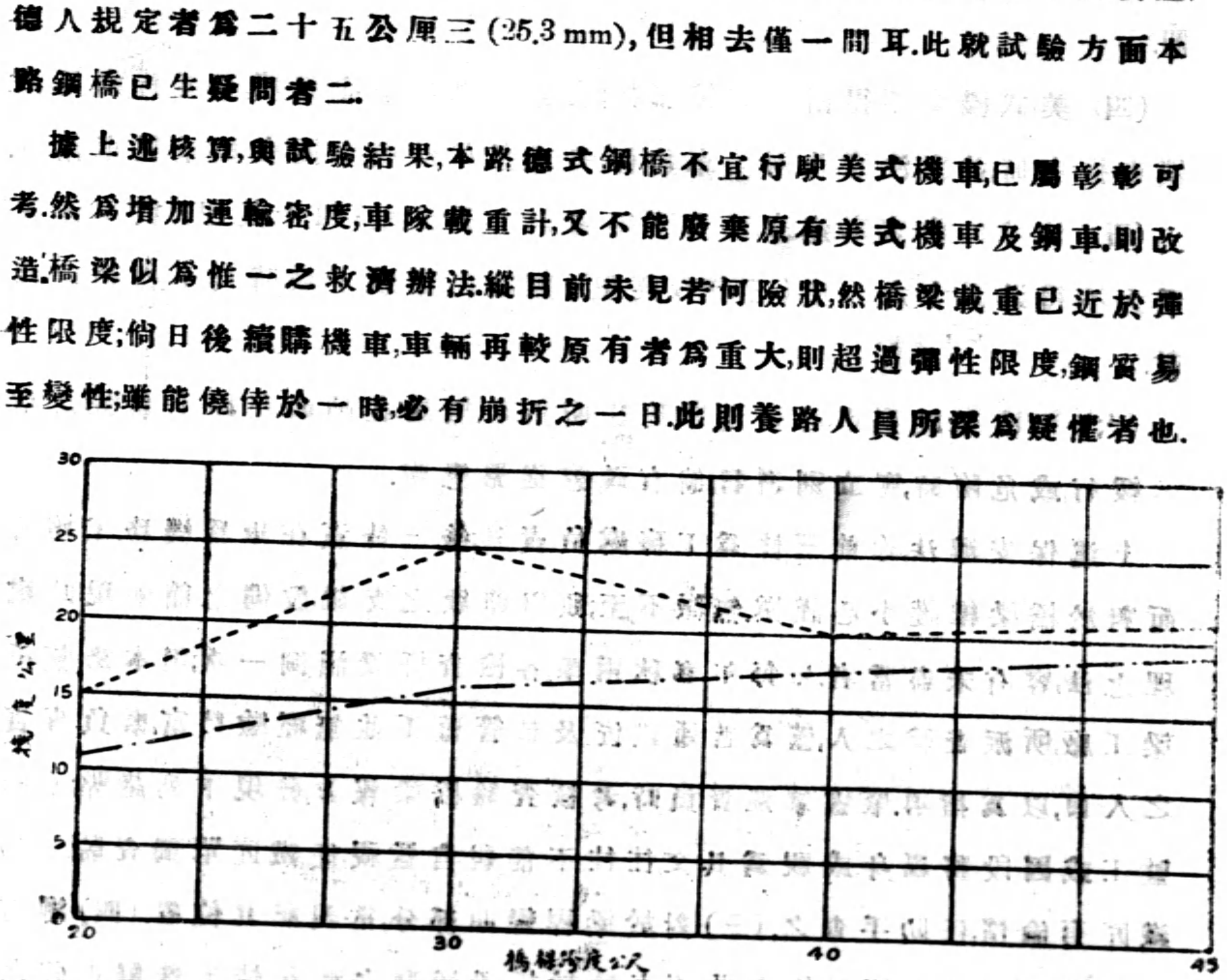
Span Ft.	Span M.	Max. Mom. No. 271—280 2—8—2	Max. Mom. E—50 2—8—0	Rating E'
10		50.7	70.3	36.0
12		72.05	100.0	36.0
15		112.35	156.2	36.0
18		152.65	212.5	35.9
20		185.75	257.8	36.0
23		238.75	331.8	36.0
27		309.25	430.8	35.9
30		372.75	513.2	36.3
33	10	439.75	597.2	36.8
47	15	781.55	1074.0	36.4
66	20	1402.54	1924.0	36.4
82	25	2120.5	2821.0	37.6
98	30	2973.5	3883.0	38.3
131	40	5147.4	6820.0	37.7
148	45	6579.5	8610.0	38.2

第 三 表　30 M. THROUGH TRUSS

Member	Total Stress E-35	Section	I Cm⁴	A Cm²	Area of Rivets	Net Area Cm²	r Cm	l Cm	l/r	16,000-70 l/r	Area In²	Allowable Stress	Rating E¹
U_1 U_3	−377,600	2 [280:10 / 95:15] 1℘ 420/10	18,900	148.6			11.3	394.0	35.0	13,550 # /in²	23.03	−312,000	29
U_3 U_4	−485,400	2 [280:10 / 95:15] 1℘ 420/20	23,150	190.6			11.0	394.0	35.8	13,550 "	29.53	−398,500	29
L_0 L_2	+226,000	2 [280:10 / 95:15]		106.6	12.0	94.6				16,000 "	14.66	+234,500	36
L_2 L_4	+455,400	2 [280:10 / 95:15] 2℘ 270/18		203.9	22.4	181.5				16,000 "	28.11	+450,000	35
U_1 L_0	−319,800	2 [300:10 / 100:16]	16 052	117.6			11 7	557.8	47.7	12,660 "	18.22	−231,000	25
U_1 L_2	+246,800	2 [260:10 / 90:14]		96.6		85.4				16,000 "	13.24	+212,000	30
U_3 L_2	−181,150	2 [220:9 / 80:125]	5 380	74.8	11.2		8.4	557.5	66.4	11,352 "	11.60	+131,700	25
U_3 L_4	+141,520	2 [160:75 / 65:125]		48 0		39.6				16,000 "	6.14	+ 98,400	24
U_1 L_1	+ 95,200	20 B Differd		70 4	8 4	59.35				16,000 "	9.20	+147,000	54
U_2 L_2					11.05								
U_3 L_3	+ 95,200	20 B Differd		70.4	11.05	59.35				16,000 "	9.20	+147,000	54
U_4 L_4													

民國十年春,木路車工機三處會同試驗濟南四十五公尺構桁橋梁,並比較德美二式機車之衝擊力.據試驗所得,撓度（Deflection）比較,美式客車用之機車,較德式機車衝擊力爲大,而美式貨車用之機車爲尤甚;且撓度隨機車速率以俱增;蓋機車主動輪旋轉率與受動建築物之震動率相調時,則引起累積之震動.此種震動,即爲長跨度上衝擊力發生之重要原因.十三年春又經前第四分段(現第七分段)試驗二十至四十五公尺鋼橋行駛德美二式機車之撓度結果,如第一圖所示.其相差之數,足證美式機車衝擊力之大,不過尚未超過規定之數.如試驗所得三十公尺橋梁之撓度爲二十五公厘,德人規定者爲二十五公厘三(25.3 mm),但相去僅一間耳.此就試驗方面本路鋼橋已生疑問者二.

據上述核算,與試驗結果,本路德式鋼橋不宜行駛美式機車,已屬彰彰可考.然爲增加運輸密度,車隊載重計,又不能廢棄原有美式機車及鋼車.則改造橋梁似爲惟一之救濟辦法.縱目前未見若何險狀,然橋梁載重已近於彈性限度;倘日後續購機車,車輛再較原有者爲重大,則超過彈性限度,鋼質易至變性;雖能僥倖於一時,必有崩折之一日.此則養路人員所深爲疑懼者也.



第一圖　美德機車經過鋼橋之最大撓度數

(三)現在處置之情形

本路北段橋梁薄弱不適行美式機車,前於試行美式機車之初,曾由車工機三處就行駛美式機車應行注意各項,會訂保安辦法數條如下:

(一)橋梁鋲釘,軌道道釘,俱應勤察;倘有鬆動,隨時修理.其橋梁全體,仍應由各該管工程司隨時考察,不得疎忽.

(二)應勤察鋼軌,有無折斷;若於折斷後,立時發覺,並施設當之處置,因而列車得免於危險者,得由該管工程司查明酌請獎勵.

(三)若橋梁軌道已有損壞,而不能察覺,因致發生事變或危險者,從嚴懲罰.

(四)美式機車,不得兩輛直接聯掛;倘遇機車在中途損壞,不能行動,另派機車拖曳時,並應注意若兩機車均係美式,應在兩機車間夾掛重貨車兩輛.

(五)津韓段內.客車速率,至大不得過六十五公里(四十英里);貨車速率,至大不得過五十六公里(三十五英里);無論誤點或下坡時,均不得超過此數.

(六)司機駕駛列車,必須遵守號誌所指示,無論在站或在路上,見號誌指示緩行,或危險時,應立刻遵行;倘有疎忽從嚴懲辦.

上述保安辦法,除前三條爲工務處負責外,後三條責在車務機務.工務方面對於橋梁維護,小心謹愼,無微不至;顧以路歧之支絀,設備之簡陋,現時處理之法,容有未盡當者.每年春秋兩季,各檢查橋梁涵洞一次;但本路無橋梁工廠,所派查驗之人,僅爲普通鐵匠及該管監工,並無經驗豐富,擔負專責之人員,以爲指導.肇鑒衆巡查員時,考核查驗橋梁報告,發現下列諸弊:(一)監工或因段務羈身,或視爲具文,往往不能親自監視,任鐵匠單獨查驗.(二)鐵匠有偷惰,任助手查之.(三)對於梁桿彎曲部分,常誤記其位置.(四)鋲釘之鬆動與否,信手標記.總之,此項查驗,於橋梁涵洞之實在情形,殊鮮正確之報告,非特設橋梁稽查,不足以資整理.

鋼橋鉚釘鬆動過多者,例須改鉚,以昭慎重;惟本路工務處,無嫻熟鉚匠,屆時非借用機務處機匠,即臨時雇用鉚匠;但此項匠工,平時既不隸屬工段,對於加鉚工作,難望完全盡心,切實負責;且手鉚鉚釘,強度較機鉚者差百分之二十,非有完備之組織,優良之設備,恐難維持固有之現狀.

本路軍事期內毀壞橋梁之數目如第五表所載,現時均用道木支架暫維現狀,亟待修理或根本改造.

第五表　津浦軍事毀壞橋梁估計表

段名	毀壞橋梁數 毀壞甚重者	毀壞橋梁數 微遭損壞者	約計 $	附記
第一總段	13 座	7 座	158,000	此項係由報紙轉錄者實數須由工務處查核
第二總段	3 „	8 „		
第三總段	3 „	1 „	18,000	
黃河橋		1 „	150,000	恢復預算
總計	19 座	17 座	$ 326,000	

津蚌段橋梁之較弱者,均先後設立慢行號誌,指示車隊慢行,藉資救濟;但積久懈生,現時司機多不注意,殊失保安初意.

各路機車重量,各與其橋梁耐力有相當之比例限度;如或超越,危險立即發生.年來軍運繁忙,往往有不問橋梁之強弱,車輛之重輕,貿然用他路機車在本路行駛;甚或雙機三機魚貫並駛,若再不設法制止,必至發生絕大危險.

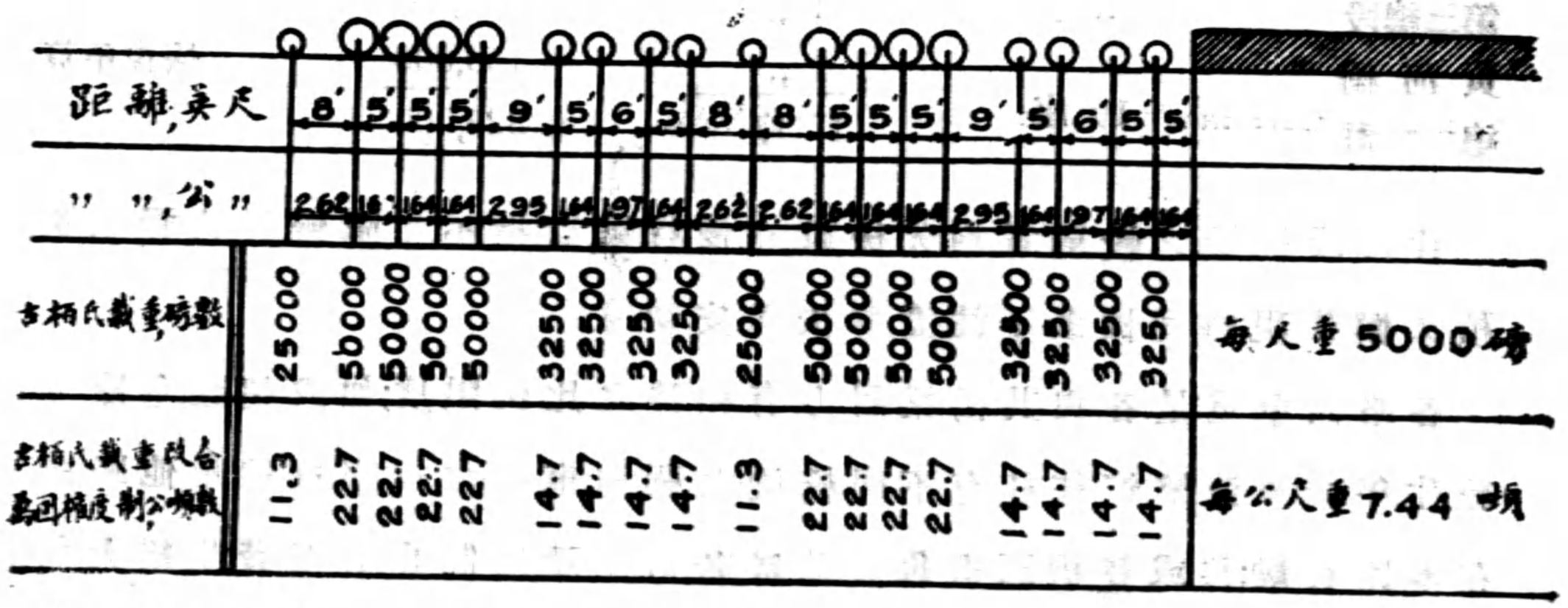
(四) 橋梁工廠之需要

橋梁載重之種類,普通以古柏氏 E 類某號表之.前交通部規定,今後幹路鋼橋之標準載重,爲古柏氏 E 類五十號 (Cooper's Class E—50 Loading). 如第二圖所示,乃參照美國習慣,以凝固式(Consolidation)機車二輛,連同煤水車,隨以列車之勻布載重,其輪數及各輪間之距離爲一定,而各輪所載之重量,則視古柏氏 E 類號數爲定,如 E 類五十號,則各輪所載之重量,爲五萬磅,E 類

四十號,則各輪所載之重量爲四萬磅,餘可類推.但國有鐵路現有之橋梁,不及E類三十五號者,仍不在少數.顧以運務發達,不能不採用強力之機車,重大之車輛,原有橋梁頗難勝任,並非因其修養之不當,或橋梁之磨損,實因建築物之原來計劃太弱,不能負荷過量之重.如漢平膠濟等路,以德法式之橋梁,而行駛美式之機車,故演橋斷車墜之慘劇.津浦北段橋梁,盡爲德式,與京漢膠濟情形頗相類似.由核算及試驗之結果,如第二節所述,目前雖未見何險狀,改建加固之謀,亦終不能避免.兼以連年軍事破壞,補苴罅漏,事倍功半,不如趁此機會,先將毀橋之載重不足者,一律改建新橋,此種工作,非自設橋梁工廠,不足以收敏捷經濟之效.

第二圖

古栢氏E—50 號載重圖



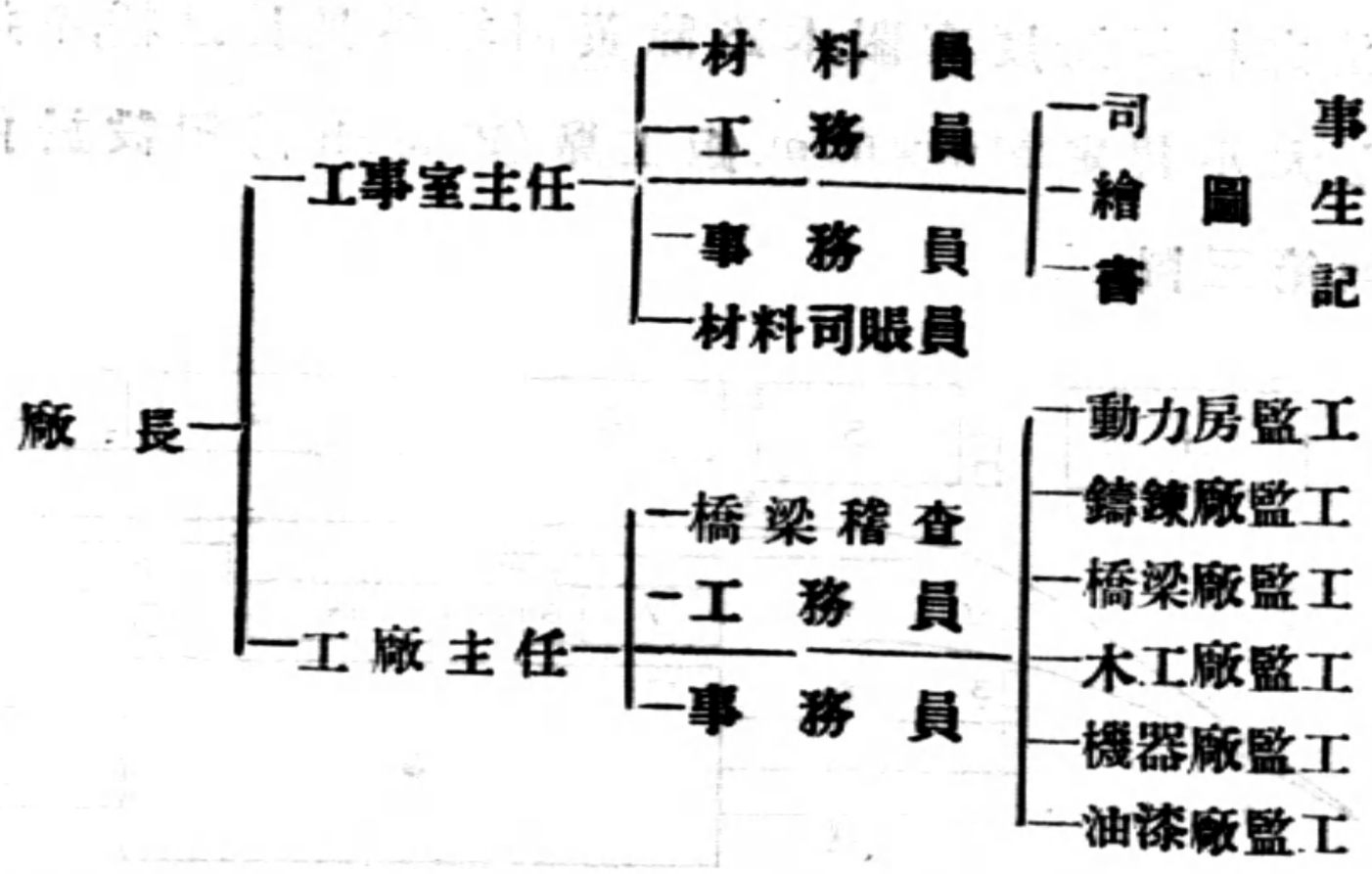
各查國規模較大之鐵路,工務處組織之下,無不設立橋梁一部,有充分之工作設備,熟練之長班工人,故指揮靈便,工作迅速,任何修理或改造橋梁計劃,均不難措置裕如.但中國國有鐵路,除平奉山海關鐵工廠規模粗具外,其他各路對於橋工之設備及工人之培儲,均欠相當之籌劃.一旦遇有緊急工程,勢必束手無策;且如極小稈件之小有損壞,尙可在野外修理者,亦須向外購買新料;此漢平所以於今春改組時,添設橋梁工段,及北段橋梁工廠,以資補救,其規模雖小,究尙有擴張之希望.津浦北段橋梁之弱,軍事毀傷之多,不

亞於漢,平鐵路,縱不能步平奉山海關工廠之後塵,亦應設立一小規模之橋梁工廠,以期從事修理工作;並於檢驗橋梁,更換鉚釘時,亦有相當負責人員,可免敷衍誤事.即黃河橋之修理工程,亦不必多方籌措;致費巨額之現金.是橋梁工廠爲本路不可少之設備,就各方需要情形論,勢有不得不然者也.

(五) 橋梁工廠之組織

本路橋梁工廠之組織,在經濟不甚充裕時代,開始創設,諸可暫從節省,以免礙及經濟.茲擬定統系如第六表:

第六表　組織統系表



(一) 橋梁廠廠長,直轄於工務處處長,總理一切橋梁工程.須兼備機械土木各種之工程學識,及駕馭員工之管理經驗,對於本路橋梁有相當之研究者充任之.

(二) 工事室主任,直轄於廠長,辦理橋梁設計,繪圖預算及收發材料事項.可就本路不管段之工程司中,擇一富有橋梁學識者兼任之.

(三) 工廠主任,直轄於廠長,管理各廠工作,並修造橋梁事項.可就本路不管段之工程司中,擇一兼具機械學者兼充之.

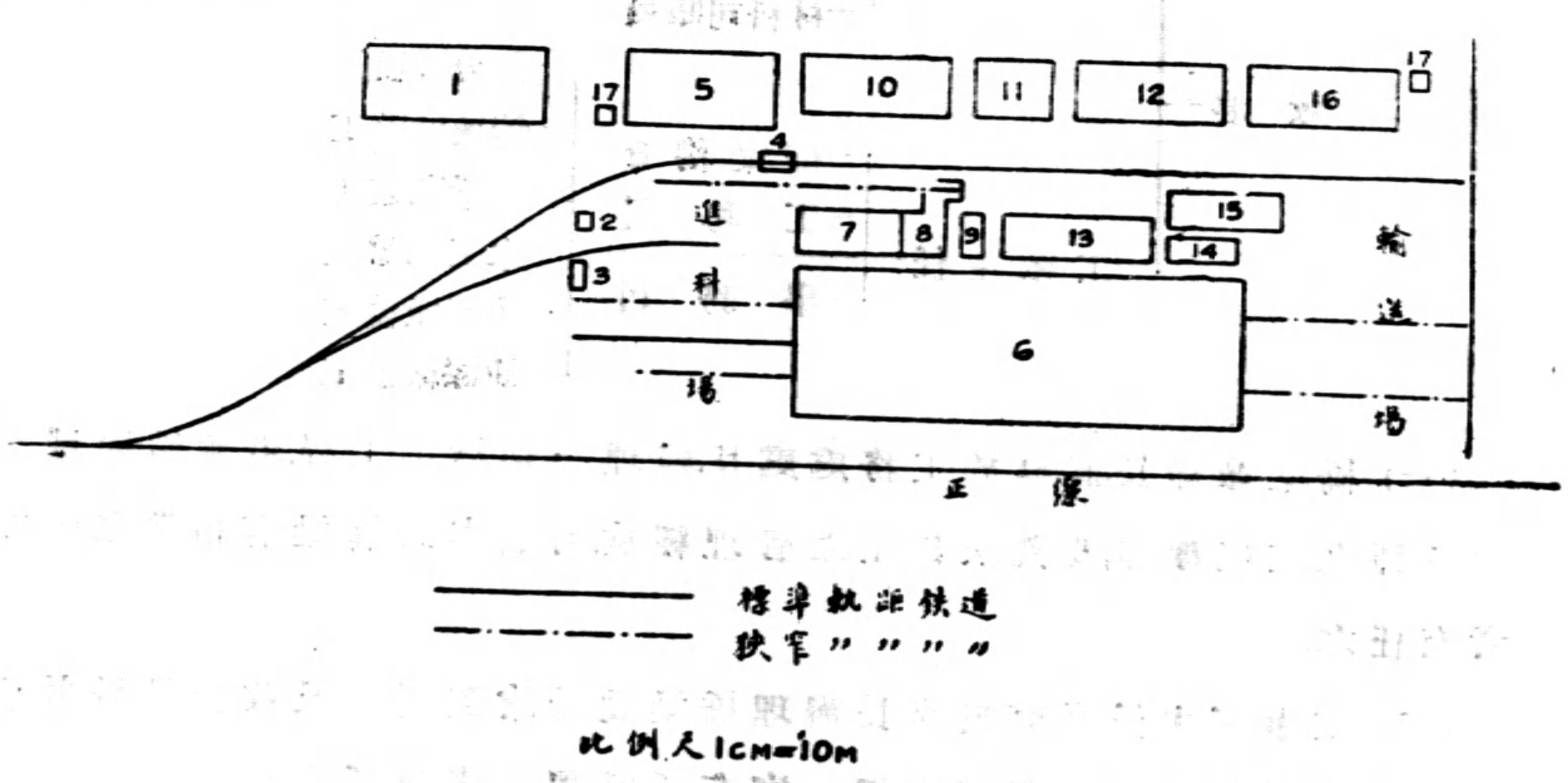
(四) 以下員司,均可分別由本路舊有人員調用,或另添雇.總以費省易舉,使路款不致虛糜,工事得以施行爲主旨.

(六) 橋梁工廠之設備

本路橋梁工廠,爲經濟所限,規模不必過大,以能周轉爲度.茲就地點,佈置,機械三種,節述於下:

(一) 地點選擇. 建設橋梁工廠,最好在水陸交通之地;蓋原料之輸入,及成品之運出,均須靈便無阻.方能指揮如意.本路適應此等條件者,以天津,陳唐莊,浦口三處爲佳.查陳唐莊原有材料總廠,餘地頗多,又在海岸旁設有碼頭,鋼料運入既便,成品輸出亦易,似以此地最爲適宜,並免購地費用.

(二) 工廠佈置. 橋梁工廠與普通鐵工廠不同者,內多橋梁廠一部;其廠屋之大小,與所造之橋梁跨度有關;本路除黃河橋外,最長之橋,不過四十五公尺;故橋梁廠之大小,暫定 20 m × 60 m. 鈑工廠 (Plate Shop) 附設於內,其他工廠之簡要佈置如第三圖.



1	大公事房	5	機器廠	9	盥洗房	13	鍛鍊廠	17	廁所		
2	看守夫房	6	橋梁廠	10	木工廠	14	鉚釘倉				
3	存物雨蓋	7	動力房	11	工廠公事房	15	油漆廠				
4	軌道磅稱	8	鍋爐房	12	材料房	16	造橋設備儲藏房				

第三圖 津浦路橋梁工廠佈置圖

(三) 機械購備. 橋梁工廠中所用機械,如起重機,衝孔機,揑釘機,鏇床,鉋床,剪機,鑽床,汽機,鍋鑪,煉鑪,汽錘,其他機械工具,及造橋設備等,種類繁多,不及備載.如決定建設是項工廠,須一面製就佈置詳圖,一面函詢各國著名行廠,俟得其說明書後,再行詳細比較,決定取舍,自不致於靡費.

(七) 建設費用之估計

建設橋梁工廠,費用可分地基,房屋,機件三目.分別估計於下:

(一) 地基. 建設橋梁工廠,地基最小須用寬七十公尺,長一百七十公尺之長方形.約合華畝一九三.五.就以二百畝計,每畝估價價一百元,共需地基費二萬元.如本路有相當空地,此款無須付現.

(二) 房屋. 房屋估價須俟設計圖製成後,方能精確,茲就經驗上估計約數如第七表:

第七表　房屋估價表

房屋名稱	大小方式	單價	共計	附記
		$	$	
橋梁廠	$20^m \times 60^m = 1200$平方公尺 鋼架建築	45.00	54,000.00	
動力房鍋鑪房	$6^m \times 20_m = 120$平方公尺 鐵筋混凝土建築	35.00	4,200.00	
機器廠	$10^m \times 20^m = 200$平方公尺 筋混凝土建築	35.00	9,000.00	
鍛鑄廠	$8^m \times 20^m = 160$平方公尺 鐵筋混凝土建築	35.00	5,600.00	
木工廠	同上	35.00	5,600.00	
油漆廠	$5^m \times 15^m = 75$ 平方公尺 磚建築	30.00	7,500.00	
公事房	$10^m \times 25^m = 250$平方公尺 磚建築	30.00	2,500.00	
材料房	$8^m \times 20^m = 160$平方公尺 磚建築	30.00	4,800.00	
造橋設備儲藏房		30.00	4,500.00	
工廠公事房	$8^m \times 10^m = 80$ 平方公尺 磚建築	30.00	2,400.00	
其他房屋			1,950.00	
總計			$100,000.00	

(三)機械工具. 機械工具等之估價,須經詳細計劃,及實地考察後,方能準確.茲就理論方面擬定,約數如第八表:

第八表 機械工具估價表

廠名	機械工具	約計	附記
橋梁廠	起重機 衝孔機 鑽釘機 剪鐵機 削角機 刨床 磅秤	$ 50,000.00	
鍋鑪房動力房	蒸汽機及鍋鑪水管等	35,000.00	以一匹馬力計算
機器廠	起重機 衝孔機 鋸床 刨床 鑽床 磨床 截螺旋器 鑿槽刨床 其他工具	25,000.00	
鍛鑄廠	起重機 蒸汽鍋 煉鐵鑪 鑄型沙箱 作螺釘機 作鉚釘機 壓機 其他工具	15,000.00	
木工廠	鋸機鋸床 刨床鑽床 其他工具	5,000.00	
油漆廠	工具	1.000.00	
造橋設備	弔車打捲機 千斤頂鉚釘機 混凝土調和機 其他工具	50,000.00	
其他		9,000.00	
總計		$ 180,000.00	

總計		
	(一) 地基	洋二萬元
	(二) 房屋	洋十萬元
	(三) 機械工具	洋十八萬元
	共計	洋三十萬元

第九表　津浦北段鋼梁重量表（黃河橋在外）

跨度	構式		孔數	總重量（公噸）	總重
10 meter	Plate Girder	Deck	49	10.22	500
		Through	9	15.13	136
15 meter	Plate Girder	Deck	29	17.25	500
		Through	10	23.54	235.40
20 meter	Truss	Deck	9	27.91	251.30
		Through	34	31.99	1085
25 meter	Truss	Deck			
		Through	2	46.49	93
30 meter	Truss	Deck	16	63.53	1015
		Through	54	58.10	3140
40 meter	Truss	Deck	14	99.39	1390
		Through	7	95.48	668
45 meter	Truss	Deck			
		Through	19	108 47	2061

北段鋼梁總重量 = 11,674.60

(八) 結　論

建設橋梁工廠,從事改造橋梁,不惟能保運務之安全,實有相當之利益.如本路北段橋梁,按交通部規定古柏氏 E 類五十號標準一律更換,新橋約須購鋼梁一萬八千噸.但現時結構鋼頗貴,平均每噸以三百五十元計算,路局須有六百三十萬元之支出.拆下之舊料總計約一萬一千噸,如第九表所示;若按上等廢鐵出售,每噸以八十元計算,約值洋八十八萬元,是全行換新之費用,約需洋 五百四十二萬元.

如路局自建橋梁工廠,則凡在十五公尺以下之鈑梁橋,均可用舊梁添加新料而改造之;約可省購鋼梁一千噸.十五公尺以上之桁橋,可用合併法改製,又可省購鋼梁六千八百噸.則改造橋梁費用估計如下:

購買新梁 18000 — (1000+6800) = 1200 噸	洋三百三十七萬元
添用新鋼料約一千噸 (每噸二百元)	洋二十萬元
改造工費約共七千八百噸 (每噸四十元)	洋三十一萬元
橋梁工廠建設費	洋三十萬元
共洋四百三十八萬元	
減去廢鐵約三千噸 (每噸八十元)	洋二十四萬元
總計洋四百一十四萬元	
全行換新需洋五百四十二萬元.	
加新改造需洋四百十四萬元.	——

兩相比較,後者可省一百二十八萬元,即係自建橋梁工廠之利益.

現在路款支絀,僅能維持目前;難明知橋梁薄弱危險堪虞,自建工廠利益滋多;然鑒於建設需費之鉅,不免觀望不前,倘一旦事變,卒至釀成巨災,不惟傷害旅客生命,抑且損壞車輛路軌鐵路,經濟及名譽上所受損失,殊非吾人所願設想者.是在主其事者,思患預防,未雨綢繆,即由購買機車,車輛價券,或客貨票,修理捐內,撥出一部經費,以充建設橋梁工廠之用,庶橋梁能保安全,運務得以發達,需要之急,似不在購置車輛下也.

如路局仍覺費重難舉,似可仿照平漢路辦法.暫設一橋梁修理廠於陳唐莊;除建立小機廠購置野外設備外,其他房屋可假用現有材料廠,水泵房及鍛廠等,不必另行新造.約有十餘萬元,即足以敷分配.則修整此次軍事毀壞橋梁,庶不致仰人鼻息.並以後橋梁一切修養工程,亦得革新整理.竊以此項最小限度之建設事業,誠爲目前不可須臾或緩,管窺蠡測,幸垂鑒

本刊啟事一

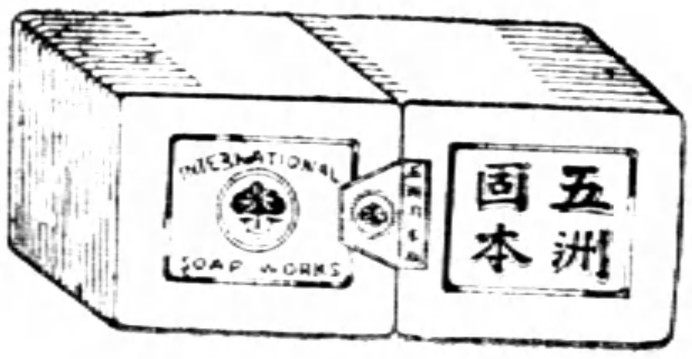
本刊自增加篇幅,改良紙張後,銷數突增,足證社會上重視本刊之深.凡各地商行公司欲在本刊登載廣告,預留地位,特刷新樣等,請函致鄙人接洽是禱.

總務袁丕烈啓

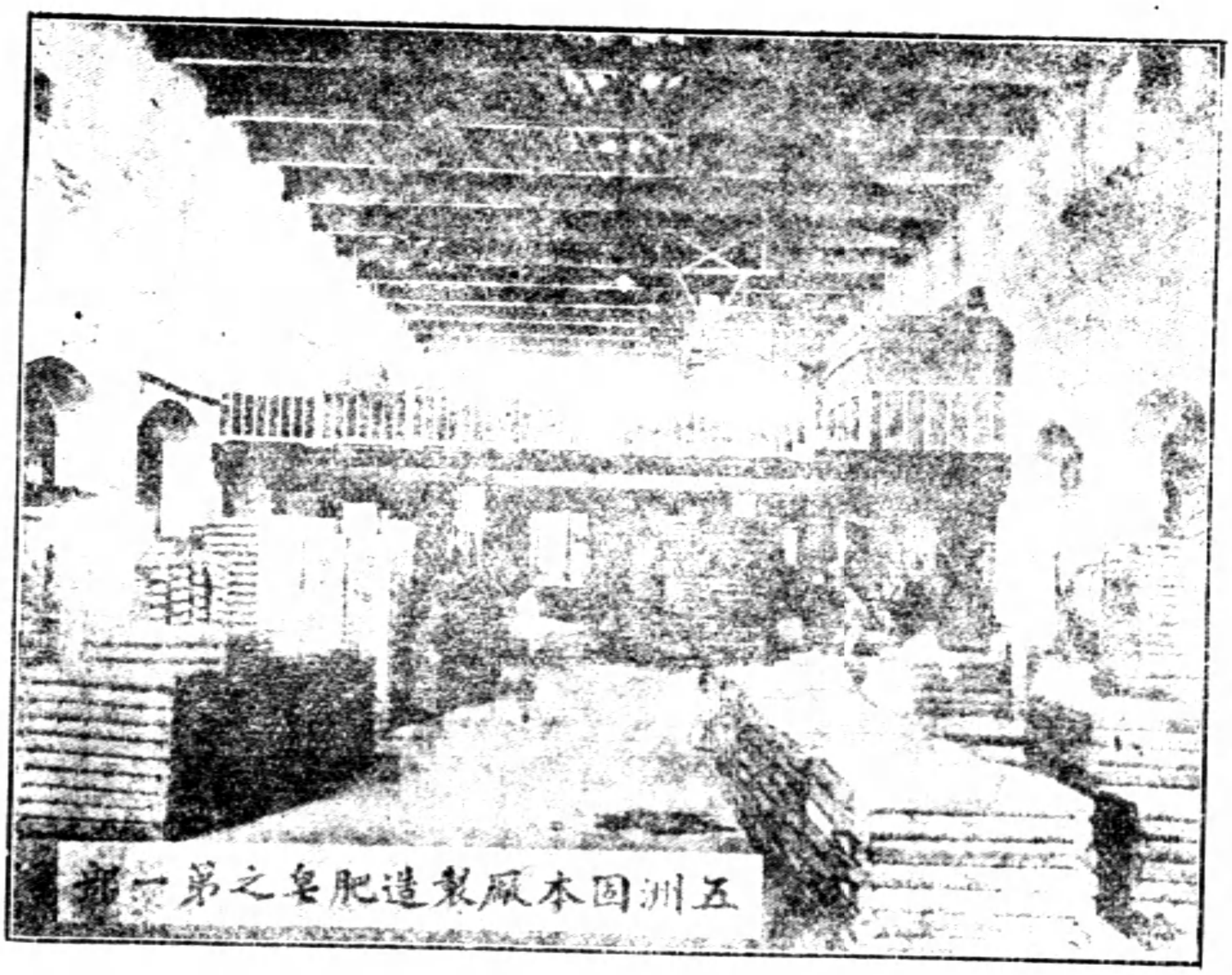
五洲固本肥皂

（貨國全完）

提倡國貨



即是救國


五洲固本廠製造肥皂之第一部

本公司在徐家滙創設五洲固本皂藥廠拓地卅餘畝內部完全德國機器分製皂製藥製化妝品衛生藥品各部男女職工五百餘人

皂部如五洲固本皂　香皂中華興記香皂　藥皂洗綢皂等百餘種藥部如人造自來血樹皮丸月月紅女界寶海波藥呼吸香膠麥精魚肝油等數百種化妝品如花露水美容霜美麗康生髮油等數十種衛生藥品如亞林防疫臭水樟腦丸殺蚊盤香等數十種貨眞價實久已馳名伏希愛用國貨君子提倡而賜教之幸甚

上海五洲大藥房有限公司暨五洲固本廠謹啟

蕪湖市政問題之一考察

著者：張連科

蕪湖爲長江重鎭之一，東南有長河一達宣城，西北有裕溪以通巢湖，沿岸各要地，交通便利，物產豐饒。現在又距首都甚近，其重要更加一等，余本年元旦應友人之約，特往一觀其附近之形勢及市街之內容。茲僅將見聞所及，加以鄙意，略述於次，敢求斯道大家之教正。

蕪湖商務繁盛，人烟稠密。現在市警區所轄範圍之面積，稱爲 14.7 方里，全市分爲 5 區，卽第一區城內，第二區長街，第三區江口，第四區河南，第五區租界。據最近調查，其各區分局所轄戶口如次：

區別	戶數	男人數	女人數
第一區	4,716	14,395	10,452
第二區	5,530	24,893	13,215
第三區	10,080	27575	17,726
第四區	4,631	10'468	7,262
第五區	1,167	2,684	2,106
共計	26,124	79,945	50,761

現在市警區內全數人口，爲130,706 人。（據另一調查，稱總數爲 135,973人，不知何者爲準，以下計算標準，係用此大數）。推其密度，約合每方里9,249人。換言之，每人所占面積，約合357方尺。（在世界各大都市之人口密度，巴黎爲每人299方尺，柏林爲331方尺，大阪爲410方尺，倫敦爲720方尺，紐約爲 1,584方尺）。其稠密之狀況，竟駕乎紐約，倫敦，大阪之上，幾與柏林，巴黎相伯仲。其面積與人口之調查，或稍欠精確，而其密度之大，已可想見。一方試觀其市內之情形，狹隘之狀，竟出乎意想之外，卽鼎鼎大名之「十里長街」，單車亦不能通行。城內外之交通，非常不便。因居民飲料，皆賴運江水之故，雖在晴天亦滿

街濘泥.其在大馬路一帶,街衢雖稍爲寬展,然亦尙欠整潔.且其各方之出路,概屬陋巷,往來亦不甚便利.在各要路交會處,若有車輛對面相逢,卽途爲之塞.常有數十分鐘不克通行之事.似此情形,再不大加整頓,將來蕪湖市街,必呈「寸步難移」之現象.卽或不然,以如此長江重鎭,電車之交通,姑暫置不論,而普通之馬車及汽車,亦難以暢行無阻,實不得不謂爲蕪湖市之一大弱點,而不足以副其盛名.然此皆有待於市政工程之計劃與設施也.惟聞當局以蕪湖市人口尙少,不足以設立市政府,凡關於市政問題,皆委之於蕪湖縣政府及公安局共同解決.須俟有二十萬人口,乃設立市政府,辦理市政.但愚以爲此十三萬餘人口之城市,不能設獨立的市政機關之根據,甚爲薄弱.試查各國都市計畫法,歐洲大陸如意大利,法蘭西及瑞典等國.皆以人口一萬以上之密集住所,須舉辦市政.英國定二萬人以上,美國則定2,500人以上,卽須實施城市計畫.德國之統計,則細分2,000人以下爲地方的居住地,2,000人至5,000人爲地方都市,5,000人至20,000人爲小都市,20,000人至100,000人爲中都市,十萬人以上爲大都市.卽日本亦以人口10,001至20,000之町村爲地方方都會,20,001人至50,000人之區域爲小都會,50,001至100,000人之市區爲中都會,100,001人以上之市區爲大都會.由此以觀,蕪湖不特爲長江之重鎭,且可稱爲市界大城市之一,其應設置獨立的市政機關,積極的舉辦市政,不待多辯而自明矣.所成問題者,任乎建設經費之有無着落耳.然據某市紳謂一般知識階級,希望興辦市政之心甚切,而海關方面,亦願極力援助.若有負責者着手計劃,則蕪湖關可附徵市捐若干成,又將現有之鋪房各捐,加以整頓,一旦動工建築,數十萬元經費,不難立辦云云.愚意若在現刻情況之下,驟設完的市政府,因組織複雜,政費龐大,市民之負擔加重,或於實際的建設事業,反裨益甚小.但可先設一「市政工程局」,直屬省政府建設廳.視建設經費來源之多寡,以確定工程之規模及步驟.一俟工程大有進展,乃組織一完全獨立市政機關,使精神上與物質上之建設,相輔而行,庶不至貽虛糜公款之譏,

亦不至呈畸形發達之象.若以之附設於其他機關,則須受重重監督,實難謀市政之自由的發展.至關於地方行政,及取締等事項,儘可暫與公安局及縣政府分工合作,自不難收事半功倍之效.在初步整理時期,此法似較爲妥善.果能見諸實行,則依蕪湖市現況之輕重緩急,對症下藥,亟應提前依次着手建設者如左:

(一) 建築沿江馬路. 蕪湖爲長江沿岸之一大商埠,已如上所述,然輪船泊岸,除太古,怡和,鴻安等有登陸碼頭外,餘皆碇泊江心.招商局雖有新式碼頭,亦廢而不用.乘客上下,大感不便.故沿江築造碼頭,已成不可或緩之事.現由驛磯山下至招商碼頭沿岸,已有較良好之馬路.將來即可依此馬路之寬度,向南順江延長.雖不必成一直線,須使之大致平滑.其彎曲凸凹之處,須略加截齊或填補.故工程比較浩大.須先有精確之測量,乃能作詳細的計劃.此項工程,大致可分爲三部;(甲)由招商碼頭南順江延長,直造至江口之江堵下.(乙)由中江堵下架一開閉鐵橋,過太平關,與河南方面連絡.(丙)再由此鐵橋之南,沿江築造馬路,直至新塍頭爲止.此路若成,不惟河北方面,立可呈今日南京下關之狀態,即河南之倘塘埠,潮音庵一帶,亦可漸次發達,地價必隨之而增,對於大蕪湖市之前途裨益,實非淺鮮.

(二) 拆城修路. 今之縣城,聞係建於萬曆三年.城垣厚一丈餘,外周7.39丈,高2.2丈.門凡八:東曰宣春,南曰長虹,西曰朔賦,北曰來鳳.宣春門迤南曰迎秀,東南隅曰金馬,長虹門迤西曰上水,再迤西曰下水.水關一,在西北隅.城低陋傾圮,不過代表昔年戈矛時代之一遺物,爲市內交通之大障礙,實已毫無保存紀念之價値,正可早日從事拆除.即依此城址(遇有凸凹過甚處須略加改正,例如桑業園附近,以達至孫公廟前利用現有馬路爲宜),連同現有城外小道,開一環狀街路,以爲將來大蕪湖市發展之一中心.同時以城內十字街附近爲一聚集點,即利用拆城所得之材料,向四方築造幹路四條:一由城隍廟前,經安義街出東門,直達農業學校.一由花街出南門,過通津橋直通

南關附近.一由剛子街經油坊巷直至西門馬路口爲止.一由樵樓過高便頭出北門,使之直抵北關附近.此項幹路,僅將現有街道,略爲放寬或改正.寬度不宜過大,使二汽車能往來自由即可,俾免多毀民居.此五路若成,不惟城內外之交通便利,沿道商店,必逐日加多,地價亦隨之而大漲.沿線住宅,雖不免略爲破壞,然所得總不止可以償失.而附近居民實受益不少矣.

(三) 加寬蕪宣汽車路. 蕪湖至宣城之間,原定修一鐵道,路基及橋梁,早經築造完竣,因事中止.土工經日既久,堅固異常.現在地方人士,已決將此路改爲長途汽車道,正從事修理,預定今春通車.惟以之作市街道路,寬度稍嫌不足.本計劃擬將此汽車道之市內部分 (卽由江岸起至長河鐵橋之間) 每邊各加人行道三公尺.幷造較良好的路面,務使「無風不起塵,有雨亦少泥」.便於步行.因現在長河兩岸,居宅密集,已無退讓餘地.將來此路通車後,沿線住宅,必漸次加多.而大蕪湖市亦有漸向此方發展之趨勢,故往來行人必衆,設不加築步道,不惟失去市街道路之價值,且行人亦頗感危險,故有急待籌辦之必要.

(四) 整理救生局巷至馬路口路線. 現在因長街不能通車,由江岸進城,必須繞道轉灣,大費周折,殊覺不便,故河北之沿江馬路完成後,卽可由救生局巷口起,闢一路順江裏里穿過新橫街,經錦綉坊美仁里前達陡門巷北口,而與現在之大馬路相銜接.幷由此東行.過中國銀行前,直至育嬰堂附近;與環狀馬路相聯絡.此實爲東西交通之一大要道,苟能見諸事實,往來當近便不少也.

(五) 整理長河兩岸. 長河爲東南各縣出長江之要道,水大時,輪船可直達宣城.縱冬枯之季,帆船亦往來甚多.此實致蕪湖市於盛況之一大源流.惟現在兩岸篷戶雜居,水棲密集,垃圾逼棄,河道漸狹.匪特有礙都市美觀,抑且危險萬狀.設不速加整頓,聽其自然,將來或至呈南京秦淮河今日之現象,塞狹隘,以至於大船不克暢行.此實蕪湖全市之生死問題,未可等閒視之.但

整理之法,須採漸進主義.務使兩岸居民,先有所準備,不至破壞過大,損失過鉅,可分數期進行.即如第一期,自布告之日起,長河兩岸之十公尺內,即不許添造房屋.同時限於若干月內,將侵入河內之水樓,一律拆除,第二期,自江口至利涉橋止,限令於若干月內,兩岸以內之房屋,須完部拆除.若查明確係私有地,則除給住戶以相當之拆讓費外,土地則依法收用.第三期,俟第二期內之房屋拆竣後,即着手建築整齊的堤岸及道路.同時限令利涉橋至通津橋之兩岸,照樣拆除房屋各十公尺.第四期,即將第三期內所築成之堤岸及道路,向東延長.同時限期拆毀通津橋至鐵橋間之障礙物.第五期,完成全段堤岸及道路,幷沿岸每隔十公尺,植桃柳各一.若此種計劃,能成事實.則當春光明媚之際,桃紅柳綠.散步或蕩舟其間,遊人之清興爲何如乎.都市之觀瞻爲何如乎.概可瞑目而想像也.

(六) 整理長街.　長街爲蕪湖市之精華,商業繁盛,人所共知.惟狹隘過甚,以致不能通車.於其商務上,不無影響.且行人往來相擁,亦殊屬危險.若再不設法改善,將令人有「行不得也」之感.惟此路因商務關係,斷不可採急進辦法,取消極的改善主義則可.市政工程局成立後,可佈告凡自中江塔下順長街至西門馬路口之攤位,一律不准擺設.當先期另闢一適當之寬宏市場,以容納之,其次,即取締各鋪戶之涼篷,限期拆除.幷改正電線桿之位置.再次,則凡遇當街鋪戶,改修門面,或重造屋宇時,必須退讓三公尺以上.如此漸次推行,經過若干年後,乃下令一律退讓.居民既早有相當之準備,不至倉皇失措.商業亦不至受其影響.而長街已變成整齊較寬之街道.今日擁擠之情形,必大可緩和矣.

(七) 整理去和街.　此路爲本市南北交通要道.雖可勉強通車,惟嫌其寬度不足,彎曲亦覺稍大.確有略爲放寬,且除去凸凹之必要.一面可向南方延長,過關帝廟,直出中江塔下,與予定之鐵橋相會.一方向北延長修理,使與租界界碑連接,直達驛磯山下.以作本街將來逐漸發展之準備.

(八) 開闢河南幹道. 河南方面,除已計劃有沿江馬路,及沿河道路外,須另闢一二幹道,貫通聯絡,以作大蕪湖市人口大增,發展之準備.以現況而觀,似可由四喜卷附近闢一路,過二街,向東南行,經前道尹署,直達觀音閣街,以與城內南來之幹路相會.另由南關附近闢一路向西南行,使與沿江馬路相接.再於此四路之間,斟酌實地情形,闢支路數條,互相聯絡.則河南方面之規模已備,而河北方面之密集狀態,亦可隨之緩和矣.

(九) 籌　　立公園. 蕪湖因無正式公園之設置,及各種遊藝場之辦理. 旅行至此者,幾有無地可以遊覽之感.其實烟雨墩之風級天然.大赭山之眺望雄闊,均屬不可多得之佳景.其他市外之足供培植者,更指不勝屈.在此田園都市之主張,風行全世界之時代.爲調和大城市人口集中後之健康問題起見,市內及近郊「綠化運動」之勃興,實非偶然.即在歐美各國,每當城市設計之時,必使有相當之空地,草地,池沼或田園地帶,存置於市內之各部,以爲市民遊息之所.試觀各文明都市之公園,占全市面積之比例;巴黎爲26%,華盛頓爲14%,倫敦爲9%,紐約及支加哥爲4%,某市政工程學者,則主張市內每100人須有一英畝之公園面積,乃得稱爲良好之計劃.此雖稍近於理想,而大城市之不可無若干公園,已足充分證明.在建設新蕪湖市之時,第一步可將陶塘,烟雨墩,汪家田,包括李家大小花園及繆家山一帶廟宇,建設一大規模之第一公園.各種高尙之遊藝場,即可配置於其間.第二步,則於大小赭山,鐵獅山,包括第五中學校及廣濟寺一帶廣植樹木,培養花草.幷利用山之高下地勢,建築幽雅之亭榭.即以之爲第二公園.第三步,乃於近郊選最適當地點,設置相當規模之植物園及運動場等.庶不至爲枯燥無趣之蕪湖也.

(十) 籌備自來水. 飲料用水之良否,不特於人體肌膚之美惡,及聲音之清濁,發生影響.且與一般衛生上及文化上有莫大之關係.惡疫流行之時,飲用水常爲病菌之媒介.故中外各較進步之城市,莫不有自來水之設置.蕪湖全市,擔用江河之水,不獨沿街淋漓,有礙觀瞻及交通.且於市民之健康保護

上,大有影響.故在市政略有發展之時,卽須籌辦自來水,以利民飲.惟此事需款浩大.或由市發行公債以自營,或募集商股以承辦,須詳考金融內情,周密規劃,乃不至有弊端發生.至於水源地之選擇,則江河上流均可,而尤以長河上流之農業學校爲佳.

以上數端,僅就旅行中數日間皮相之結果,對蕪湖市之現狀,作一草率的計劃.所舉者皆認爲在十年內「應辦」而且「能辦到」之舉舉大者.決非徒託空言,畫一空中樓閣,以驚世駭俗,至於全盤的百年大計劃;如市區之應如何擴充劃定,商工業區域及住宅區域之應否嚴密的劃分,路線方式之確定,各支路之配置聯絡,全市上下水道之詳細的規劃,小菜場之配置,市街電車及郊外電車之籌備以及橋梁之架設等等.雖亦略具意見,然非先有精確的測量,及詳密的調查.不免紙上談兵,難俾實用.且此非有限的個人學術及工程知識,所能完全解決,將留以待斯道大家之研究討論,故略而不記.總之,新都既定,蕪湖市近在咫尺,其重要性已日益加大.一旦寧蕪間鐵路開通,則大蕪湖市之發展,更可想見.是則居今日而計議及蕪湖之市政工程問題,或亦可免妄唱高調之譏歟.

本刊啟事二

徵稿　本刊爲吾國工程界之唯一刊物,同人等鑒於需要之亟,故力求精進,凡會員諸君,及海內外工程人士如有鴻篇鉅著闡明精深學理發表良善計劃以及各地公用事業如電氣,自來水,電話,電報,煤氣,市政等項之調查,國內外工業發展之成績,個人工程上之經營務望隨時隨地,不拘篇幅,源源賜寄,本刊當擇要刊登,使諸君個人之珍藏,成爲全國工程界上之南針,本刊除分酬本刊自五本至十本外,幷每期擇重要著作數篇,印成單行本若干,酬贈著者,以答雅誼.

書報介紹　凡諸君研究所得,有新穎及名貴之著作,或編訂成帙或分載雜誌者,均希將書名,篇名,著者姓名及其內容提要註明,寄交本刊,當於本刊書報介紹欄內陸續公佈,以公同好.

烏桕子及其產物

STILLINGIA SEBIFERA AND ITS PRODUCTS

著者：沈熊慶 錢嘉集

烏桕子爲中國特產,其樹有野生與培栽兩種.野者生於台灣及中國各部,其在湖北,湖南,四川,江西貴州等省者,都經培植.桕子分二層:外層係白色臘狀之油脂,名中國植物脂(Chinese Vegetable Tallows),俗名皮油,爲製皂燭之原料.內層係果仁壓榨時則得黃色清油,英名(Stillingia Oil)俗稱之曰清油,子油,或梓油.子油亦爲肥皂原料,吾國內地向用之燃燈.按中國醫書桕油能治瘍腫諸症,且是瀉藥,作用與蓖麻油同.惟桕油之最大效用則爲製造油漆,因其乾性甚强,價亦低廉.國人屢以入桐油以減成本.美國漆業則用代桐油,據該國漆業專家 Toch 氏云,光澤富乾性之凡立水,已用桕油爲原料,可知此油如以適當之乾燥劑,定能在油漆工業上佔一重要位置,或將取亞麻仁油而代之.著者有鑒於斯,曾用各種乾燥劑爲製油漆之試驗,所得結果誠不出所料也.

是篇詳述桕子,桕油,皮油之化學與物理性狀,油脂之提取法,精製法等等.並附著者各種實驗,以備有志研究者之參考,如蒙海內外化學家指教則幸甚矣.

INTRODUCTION.

Chinese vegetable oils have long been occupying an important place in world market. The most well known example is China wood oil. But little attention has been given to the valuable products obtained from the seeds of Stillingia Sebifera. The seeds as we know yield two kinds of products, a fat and an oil. The latter is a very good drying oil. Should proper driers be found it can compete successfully with linseed and China wood oils. Attempts were therefore made to study the effects of several driers on this oil. Our results show that stillingia oil has a better drying power than linseed oil.

Since vegetable tallow contains palmitic and oleic acids, attempts were made to prepare them in a pure state. Pure palmitic acid and pure oleic acid of a slight reddish color were actually obtained. On account of lack of time, the characteristics of the latter were not determined.

Finally the paper tries to give a general review of the seeds and their products so that further investigation may be intelligently worked out.

CHEMICAL AND BIOLOGICAL DESCRIPTION OF STILLINGIA SEBIFERA.

Stillingia sebifera may be wild or cultivated. Wild trees are found in Formosa and practically in every part of China. But in Hupeh, Szechwan, Hunan, Kiangsi, and Kweichow provinces, the tallow trees are planted and grafted. Those places produce yearly great quantity of oil and tallow. Occuring in the hilly regions, or near the rivers a tallow tree usually grows to a height of 20 feet. It is also called Sapium Sebiferum, Roxb belonging to the family of Euphobieceac.[1] It is a deciduous tree. During Autumn, the leaves become dark red. After the falling of the leaves, we can find seeds in black husks attaching to the stems of the plant. Within each of them can be obtained three waxy seeds.

The composition of the seeds is shown in the following tables:

TABLE I[2]

Composition of the seeds.

	Soochow product	%	Hihyu 歙縣	%
Weight of seed	0.1382 grams		0.141	32.11
Mesocarp	0.0388 „	28.08	——	32.11
Fleshy mass inside	0.0475 „	34.36	——	31.50
Black covering between	0.0519 „	37.56	——	36.38

TABLE II[2]

Chemical composition of the mesocarp.

	Soochow product	Hihyu product
Water	3.87%	1.14%
Nitrogen	1.40%	——
Cellulose matter	1.04%	——
Albuminoid	8.75%	——
Tallow (other extract)	76.40%	70.33%
Non-nitrogenous Compound	8.29%	——
Ash	1.64%	2.85%

TABLE III[2]

Chemical Composition of the Fleshy Mass Inside.

	Soochow product	Hihyu product
Water	6.37%	2.10%
Nitrogen	2.32%	——
Albuminoid	14.50%	——
Oil (ether extract)	58.02%	66.12%
Cellulose matter	6.24%	——
Non-nitrogenous compound	12.36%	——
Ash	2.51%	1.23%

TABLE IV[2]

Chemical Composition of the Hard Covering between Mesocarp and Fleshy Mass

	Soochow product	Hihyu product
Water	8.27%	7.22%
Ash	2.32%	2.58%
Other Products	89.41%	90.20%

From the mesocarp of the seed a white waxy substance is obtained. It is known as Chinese vegetable tallow or Pi Yu (皮油). The kernel of the same seed yields on expression a limpid pale-yellow oil known as stillingia oil. In China it is called by three names, Tze Yu (子油) or Tsing Yu (青油) or Tsin Yu (梓油). A mixture of the tallow and the oil obtained from the crushing of the whole seed is called Mu Yu (木油).

According to Tortelli and Ruggeri[3] 22% of the seed was tallow, and 19.2% was stillingia oil. On the other hand, Schindler and Waschata[4] found that tallow amounted to 36.4% of the seed and Lewkowitsch[5] obtained 23.29% oil. These results need further confirmation.

Besides the valuable products obtained from the seeds we must not forget that leaves and timber of the tree are also very useful. From the leaves, a black dye can be manufactured while the timber is very suitable for carving.

CHINESE VEGETABLE TALLOW

Of the two valuable products, vegetable tallow will be discussed first.

METHOD OF EXTRACTION.[6]

The fruits when ripe in Autumn are collected. Each of them contains three eliptical seeds in a dark hard shell. These seeds when taken out are white and smooth. The outside white covering, mesocarp, can be

separated from the kernel which contains a yellowish fleshy mass. Seeds are heated in a wooden vessel, the size of which is variable, about 4 feet high and three feet in in diameter placed upon a bamboo screen in an iron pan filled with water. The fire place is a cell dug in the ground. The iron pan just acts as a water bath. When the seeds are sufficiently heated, they are transferred to a brick lined mortar and pounded with a wooden pestle which is moved by means of a lever with the aid of feet. Pounding keeps on until black kernel appears and the whole meal is transferred to sieve. By shifting, the mesocarp and black kernel are separated. The mesocarp is used to manufacture vegetable tallow while the kernel is kept for stillingia oil. The separated mesocarp is ground to powder in a stone roller which has a diameter of 0.8 feet and a thickness of 5 feet, and is attached to an axis in the center of a trough. After powdering, it is heated in an iron pan until it becomes sticky and soft. With iron hoops and rings, the sticky mass is made into cakes. Fifteen to twenty cakes are placed in a wooden press to press out the oil by means of wedges hammered into the press. Process stops when all the oil is expressed. The oil just coming out assumes a yellowish color, but in contact with air and sun-rays, it solidifies and whitened. This shows that sun-rays has the power to bleach the tallow. The tallow made from the mesocarp from the first seiving is of the best grade. Sometimes more heat is added to the seeds partially freed from mesocarp and a second seiving is applied. The tallow obtained from the material seived out is of the second grade. Both are named prima vegetable tallow.

By this method, out of one tou or 15 catties of the seed, 2 catties of vegetable tallow can be obtained. It is fairly pure. So refining is not necessary. Should new methods be applied, more tallow can be obtained. Hydraulic pressing is very suitable.

In close resemblance with the first, another kind of product is usually made and sold in the market under the name of secunda vegetable tallow, or Mu Yu (木油).[7] It is really a mixture of tallow and liquid oil. The whole seed is heated and ground without separation of the mesocarp from the inside part. The meal is pressed as usual. It is soluble at F. 95 degrees while prima vegetable tallow melts at F. 150 degrees.

Prima vegetable tallow[8] can be obtained, if so desired, from secunda product by steeping a bunch of grass in the liquid oil over night. Crystals of prima tallow will be deposited on the grass next morning.

Experimental: The writers prepared a small quantity of tallow by using solvent-extraction method. He used Soxhlet Extractor with ether as the solvent. A bottle of the seeds was collected from the trees on the campus. They were first separated from the outside hard husks and put in the thimble within a glass cylinder which was connected to a flask containing ether. The flask was heated on a water bath for about six hours. The temperature was kept between 40—80°C. At the end of six hours, the seeds were completely free from tallow. The process was stopped. After distilling off the ether. a pure product was obtained.

Physical and Chemical Properties.

Vegetable tallow, when pure is a white waxy solid at ordinary temperature. It does not leave a greasy spot on paper. It is pretty hard. Though insoluble in water, it is quite soluble in ether, hot alcohol, carbon disulphide, benzene, and ether organic solvents. It has no appreciable odor when cold. Its physical and chemical properties are summarized in the following tables.

Table V [9]

Physical and Chemical Characteristics of Vegetable Tallow.

Product	Specific gravity	Melting point	Solidifying point	Saponification number	Iodine value	R.M. value	Observer
Commercial	0.9217	36-46	——	179-203	23-38	——	Allen
——	——	43-46	24.2-26.2	200.3	32.1-32.3	——	Lewkowitsch
Lab. ext.	——	39-42	32	203.3	28.5	——	Hobein
Commercial	——	36.5-44.2	27.2-31.1	197-202.2	28.5-37.7	——	De Negri & Shurlate
Unknown	0.86 (100°C.)	52.5	37.7	231	19.0	0.69	Zay & Musciacco
Unknown	0.918	44.5	26.7	——	——	——	Thomson & Wood
Commercial	0.8843 -0.904	35-40.5	——	206.2	9.32-60.76	——	中森廷一
Unknown	0.890 (15.50°C.)	33	28.3	205.7	36.3	——	Seifert
折 曼	0.9032	42.5	——	201.2	36.52	——	許炳熙
莉 州	——	38.0	——	200.8	40.45	——	,,

TABLE VI(9)

Physical and Chemical Characteristics of the Fattty Acids from Vegtable Tallow.

Product	Melting point	Solidifying point	Sapon. value	Iodine value	Observer
Commercial	39-57	——	——	——	Allen
Commercial	——	52.1-53.5	——	34.2-34.3	Lewkewitsch
Lab	49	40	206.4	39.2	Hobein
Commercial	53-56.9	45.2-47.9	202-208.5	30.3-39.5	De Negri & Shurlate
Commercial	——	53.5-53.6	222.9-222.5	31.1-35.67	中森廷一
折　雪	——	52.5	216.4	38.4	許炳熙
荊　州	——	50.6	210.5	42.6	〃
Unknown	56.4	55.8	——	——	Jules & Jean
Commercial	41	51	207.9	38.1	Hobein
Commercial	42	47	207.9	54.1-54.8	De Negri & Fabris

TABLE VII

Physical and Chemical Characteristics of Vegetable Tallow obtained by Ether Extraction Method

Tallow	Specific Gravity	0.906
	Acid value (one week after extraction)	1.96
	Sapenification value	208 4
	Iodine value (Wijs)	28.45
	Melting point	42.5°C.
	Insoluble fats (Hehner)	94.60%
Fatty acids from tallow	Solidifying point (Titer)	51.5°C.
	Melting point	62.0°C.
	Saponification value	212.6
	Iodine value	30.06

CHEMICAL COMPOSITION

The chemical compositions of vegetable tallow have been carefully studied by many chemists. Makelyne found in vegetable tallow two kinds of acids, palmitic and oleic. Hehner and Mitchell [10] had the same result. The solid acid had an iodine value 28.87 and was shown to be free from stearic acid. This fact was later confirmed by Kliment [11] 中森廷一 [21] stated that tallow contained 65.2% palmitic acid and 34.8% oleic acid (iodine value 88). The melting point, iodine value, and neutralization value of the solid acid were found by him to be 60.4°C., 0.33, and 218.8 respectively.

Experimental: On account of limit of time, the writers had no chance to determine the composition quantitavely but these two acids were obtained from the tallow with the view of preparing pure oleic acid.

The method used for the separation of palmitic from the oleic acid is a new one, developed by Professor Kahlenberg of the University of Wisconsin. The success of the process depends upon the fact that magnesium oleate is completely soluble in a mixture containing 70% of pyridine and 30% of water heated to 45—50°C., while magnesium palmitate is entirely insoluble in that liquid.

The first step, therefore, is to prepare sodium soap from the tallow, 100 grams of tallow were gently heated with enough alcohol to cover it in a flask and 25 grams of sodium hydroxide dissolved in alcohol were added with good stirring. The content was digested under a reflux condenser for 26 hours in order to get complete sapenification. Alcohol was constantly added. Care should be taken that the flask was not over heated or too much alcohol had been added. Otherwise strong feaming might result. Digestion was stopped when tallow had been completely saponified. The soap when melted exhibited a dark reddish color. It was cooled and dried.

The next step was to prepare magnesium soap. 100 grams of dried sodium soap were taken and dissolved in a liter of hot water, and filtered through a piece of cloth. A cold 10% magnesium sulphate solution was gradually added accompanied with good stirring until all the soap was completely precipitated. The precipitate was filtered and thoroughly washed with water. It was white in color.

The third step was to extract magnesium oleate from the soap. It was effected as follows:

50 grams of dried magnesium soap were taken and heated in about 100 c.c. of 70% pyridine solution to 45°C. about twenty minutes with constant stirring. The solution was filtered and the insoluble part was again treated with 70% pyridine. The process was repeated three times. The filtrate containing magnesium oleate was orange in color. It was treated with an excess of concentrated hydrochloric acid in order to decompose magnesium oleate and at the same time to neutralize the pyridine. An excess of acid should be used until pyridine odor was no longer perceptible. Pure oleic acid was separated on the surface of the liquid. During the addition of phydrochloric acid, the following points must be carefully noted, otherwise, instead of pure oleic acid, a sticky resinous substance will be obtained.

1. The solution must be cooled with ice as heat is developed when hydrochloric acid is added.
2. The addition of acid should be as slow as possible.
3. Vigerous stirring during addition is indispensible.

Oleic acid was then separated with a separating funnel and washed several times with water until completely free from pyridine and chlorides. Then it was dried on the water bath. It had a reddish color. On standing, it became turbid probably due to the abserption of moisture. On heating to 100 degrees, it underwent a color change to a very dark liquid. Therefore, the best way to get rid of moisture is to extract the oil with ether and then on the evaporation of the latter a clear liquid is alway obtained. The color of oleic acid deepens gradually on standing even at ordinary temperature.

The pyridine solution became dark on standing overnight. This was due to the crystallization of pyridine hydrochloride, which could be obtained by evaporation. The hydrochloric acid used should be pure and free from color. The pyridine used must be colorless. It should be redistilled if it is slightly colored.

The insoluble part of the soap was carefully washed several times with water. Enough hydrochloric acid was added. White palmitic acid was separated. It was filtered and washed several times with water. After recrystallizing from a small quantity of hot alcohol, the acid obtained was a white crystalline mass having a melting point of 62°C.

USES.

Vegetable tallow is chiefly used in the manufacture of soaps and candles. The best quality and second quality which are very white are used in making high grade toilet soap while the third and fourth qualities which are of greenish shade, for cheaper soaps.

Since tallow contains about 35% oleic acid and 65% palmitic acid, so in future it may be utilized for the manufacture of these two acids.

Vegetable tallow sold in the market is usually leaded in baskets larger at the top. A solid cake is about ½ of an inch high with a diameter of 16 inches. The outer layer of the cake is white and hard but inner layer is darker. The whole cake is made up of two grades of tallow. The outer portion is first made and then the second portion is poured in.

STILLINGIA OIL.

Stillingia oil, a limpid pale-yellowish oil, is obtained from the crushing of the kernels of stillingia sebifera. Commercial method of preparation is as follows:

The kernels separated from mesocarps, are ground in a stone mill to break up the dark covering. The ground mass is then put in a wind mill which, when turns, drives out the broken coverings and leaves the heavy fleshy part behind. It is pulverized in a stone roller and moulded into cakes. They are then heated and pressed. The oil obtained is usually dark in color and appears turbid. On standing, it will become clear with the deposit of sendiments. About two and half catties of oil can be expressed from one tou or fifteen catties of the seed. With hydraulic press, the yield in oil will be increased. Since only a gentle heat is required in this case, the oil obtained has, therefore, a much better color. In the laboratory, it can easily be extracted with ether. The oil obtained is clear and pale yellowish.

OIL REFINING.

Commercial stillingia oil is always dark in color which is probably due to over heating. It contains mucilaginous matter, coloring substances, and free fatty acids apart from mechanical imperities and moisture. Refining is, therefore, necessary.

Refining with sulphuria acid has been tried by some workers but the result is poor and the loss is great. According to Hsu ,[13] the oil can best be purified by using 12.5% sodium hydroxide aolution. The oil after this treatment is clear and has a pale yellow color.

Experimental: The writers used a modified Hsu's method to purify the oil with good results. 8c.c. of sodium hydroxide solution having a specific gravity of 1.2 were mixed with 100 c.c. of the commercial oil with thorough stirring. The whole mixture was heated between 60—70°C. for 33 minutes with constant stirring. It was then cooled in air and washed with boiling water three times with a separating funnel, the curdy oil was carefully separated from water. It was then dehydrated by heating on the water bath. A clear oil of light yellow color was obtained. A better way is to dissolve the oil in ether and then on the evaporation of the solvent, clear oil results.

Physical and Chemical Properties.

Stillingia oil has an odor somewhat like China wood oil but much fainter. Its solubility in organic solvents is pretty high. One liter of

alcohol dissolves 42.8 grams of oil at ordinary temperature. It has good drying power. Its viscosity is low. According to Lewkewitsch,[14] its optical retation is -29.9 (saccharimeter degrees).

TABLE VIII[15]

Physical and Chemical Characteristics of Stillingia Oil

Oil	Spec. Grav.	Sapon. Value	Iodine value	R. M. value	Thermal test	Refractive index (Butyrorefractmeter)	Observer
Unknown	0.9458	203 8	154.6	——	——	——	Hebein
„	0.9432	210.4	160.6	0.93	136.5 maumene	75 (35° C.) 1.4825 (23°.50° C.)	Tortelli & Buggeri
„	0.9395	——	60.7	——	——	——	Nash
Kashing	0.9542	208.5	158.4	——	——	——	許炳熙
„ Re.	0.9426	206.8	160.8	——	——	——	„
Comm.	0.9390 -0.9460	(15.5 C.) 203-210	145-160	TiterTest	12.2° C.	——	Laucks

TABLE IX[17]

Physical and Chemical Characteristics of Fatty Acids of Stillingia Oil.

Oil	Melting point	Solidifying point	Sapon. value	Iodine valne	Observer
Unknown	14.5	12.2	214.2	161.9	Tortelli & Ruggeri
„	——	——	216 3	181.8	Lewkowitsch
Kashing product	15.5	——	208.4	160.2	許炳熙
Kashing refined	15.0	13.2	210.6	168.6	„

TABLE X[18]

Physical and Chemical Characteristics of Stillingia Cil Obtained by Ether Extraction Method

Specific gravity d_{10}	0.9455
d_{15}	0.9382
Acid number	5.21
Free fatty acid (Oleic)	2.6%
Sapenification value	198.6
Iodine value (Wijs)	160.8
Hehner—Insoluble fatty acid plus unsaponifiable matter	94.6%

TABLE XI[18]

Physical and Chemical Characteristics of the Fatty Acids contained in Stillingia Oil mentioned above.

Solidifying point	12.6
Melting point	15.4
Saponification value	208.4
Iodine value (Wijs)	168.8

Chemical Composition of Stillingia Oil

As to the chemical composition of stillingia oil little has been known. According to Hsu, the oil contains 10.18% saturated fatty acid having an iodine value (wijs) of 10.4 and 84.32% unsaturated fatty acids (Iodine value 180.4). In the unsaturated fatty acids, linolenic, linolic, and oleic acids are present. Their percentages are given in the following table.

Table XII[19]

	Actual amount attained	After correction	Percentage	Iodine value
Linelenic	10.56	10.48	8.90	38.72
Linelic	76 43	76.01	64.53	137.86
Oleic	13.66	13.51	11.48	12.16

Uses.

Stillingia oil has a wider usage than vegetable tallow.

1. It has been used for years as an illuminating oil in many places of China. Even at present we can still find its use in the interior parts of China where kerosene is too expensive and electricity is unknown.

2. It is also used in soap manufacture.

3. As stated in Chinese medical books, this oil is used in medicine. It has he same function as castor oil It is also used to treat boils and to make black hair dyes.

4. Perhaps the most important use of stillingia oil is in the paint industry. On account of its cheapness as well as of its drying property stillingia oil has been widely used to adulterate China wood oil. In U.S.A. it is used as substitute for the same oil. Hard drying, glossy varnishes[20] have been made from it. The drying power of the oil is just as good, if not better, as that of linseed oil. Therefore with suitable driers it can be used to prepare boiled oils for paint.

The writers tried several driers with satisfactory results. With manganese tungate, and lead tungate as driers, the boiled oils gave transparent, hard and fainty yellowish membrames. They all dried within 16 hours while those made from linseed oil dried in 17 hours. So it is evident that stillingia oil has a higher drying power than linseed oil. The results are given in the following table along with those obtained by Hsu.

TABLE XIV [21]

Effect of the various driers on stillingia oil

Siccative	Weight in Grams	Time of boiling in Hours	Temperature	Linseed oil		Stillingia oil		Additional weight due to O_2 absorbed	
				Time	Appearance	Time	Appearance		
Pb O	1.0	2¼	220	6 hrs.	faint color	10 hrs.	yellow & hard	12.82%	Hsu
O_2	1.0	2½	240	6 ,,		20 ,,	brown	11.83%	
Zn O	0.5	2¼	250	4.5 ,,	faint	not drying	not so hard	——	
Pb $(C_2H_3O_2)$	1.0	2¼	220	40 ,,	no color	20 hrs.	hard	13.21''	
Pb B_4O_7	1.0	2	240	40 ,,	faint	20 ,,	brown slightly hard	18.25''	
Pb resinate	1.25	2	150	40 ,,	faint	16 ,,	yellow hard	20.06%	
Mn SO_4	1.75	2	240	40'' ,,	no color	not drying	yellow	——	
Mn B_4O_7	0.50	1	230	20 ,,	,,	36 hrs.	yellow not-like	12.17%	
Mn resinate	1.0	2	200	—	—	16 ,,	yellow hard	20.00%	
Mn Pb resinate	1.18	1½	150	—	—	16 ,,	faint hard	21.20%	
Lead tungate	0.50	2	200	17	a little	17 ,,	hard membrane	—	Shen and Chien
Mn tungate	0.50	2	200	17½	hard	16 ,,	hard & transparent membrane	—	
Cobalt tungate	0.50	2	200	17½	sticky	16 ,,	hard membrane	—	
Lead borate	0.50	2	200	18	hard		no good too think	—	

According to Lewkowitsch,[22] Stillingia oil absorbed 8.72% and 12.45% of oxygen after 2 and 8 days respectively in Livaches' Test. Hsu gave the following results.

TABLE XV [23]

Date	*0.1 gram of oil dried at 15°C.* % Adition in weight	*0.6 grams dried at 20°C.* % Addition in weight
1st day	3.23	5.25
2nd day	7.16	8.27
3rd day	8.62	9.65
4th day	9.53	10.21
5th day	10.34	10.96 } drying
6th day	11.06 } drying	12.50 } drying
7th day	12.26 } drying	

EXPERIMENTAL: PREPARATION OF DRIERS.

1. *Lead tungate.* a. Preparation of sodium soap of pure China wood oil. Same method was applied as in the preparation of sodium soap of stillingia oil.

b. Preparation of lead soap. 50 grams of dried sodium soap prepared above were dissolved in 400 c.c. of hot water. A solution of 10% lead nitrate was gradually added into the cold soap solution with stirring until complete precipitation was effected. The precipitates were filtered and washed several times with water until the filtrate contained no trace of nitrate. Lead tungate obtained was a sticky mass. On allowing to dry it assumed a yellowish color.

2. *Manganese tungate.* This was prepared just in the same way as above. A solution of manganese chloride was used instead of lead nitrate. The product had a dark yellowish color.

3. *Cobalt tungate.* Same method of preparation was applied. Solution of cobalt choride was used. The precipitate had a beautiful violet color; but on standing, the color gradually faded.

In place of China wood oil, the corresponding driers were prepared from rosin and linseed oil. The resinates were coarse precipitates while the linoleates were fine. Cobalt linoleate had a bluish color which changed on drying.

PREPARATION OF BOILED OILS.

25 c.c. of stillingia oil were put into a beaker and 0.5 grams of lead tungate were added. The mixture was heated for 2 hours at a temperature of 200°C. Stirring was constantly applied. The boiled oil obtained was a little dark in color and rather thick. Using manganese tungate as

drier, the boiled oil had a reddish color and was thinner while that from cobalt tungate had a brown color.

Lead borate can not be used for the resulting boiled stillingia oil was too thick to be of any value. Boiled linseed oils using lead borate or manganese tungate as driers had a yellowish color and much thinner, while using lead tungate or cobalt tungate as driers, the color was dark and the fluid thick.

In general, the boiled stillingia oils were comparatively thicker and darker in color than the corresponding boiled linseed oils. But the former dried more rapidly than the latter and gave better transparent films.

In preparing the boiled oils, the drier and the oil must be perfectly dry otherwise splashing occurs. Stirring is always necessary. Temperature must be carefully noted because it has intimate relations with the color of the resulted oil.

Present Market Value of the Oil and the Tallow.

The principle producing centers for vegetable tallow and stillingia oil are Hupeh, Szechwan, Hunan, Kiangsi, and Kweichow. In Hupeh province, Ichang (宜昌) produces 50,000 piculs of the tallow yearly; Shihnan (施南), Yunyang (鄖陽), Kiangshan (京山), Kwanghwa (光化), Suichow (隨州), 10,000 piculs; Tsaoyung (棗陽), 4,500 piculs. Price per picul varies with locality. In Hangchow, it costs about $15 to $16 a picul, while in Kinhwa, it only costs $11 to $12 a picul.

The yearly export of the tallow to various countries is as follows:(24)

Year	Quantity in piculs	Amount in Hankow Teals
1910	159,302	1,594,715
1911	44,995	0,480,652
1912	214,349	2,333,759
1913	220,998	2,266,961
1914	191,058	2,074,284
1915	181,824	1,962,179
1916	256,960	3,011,695
1917	151,385	1,782,938
1918	162,881	2,123,869
1919	164,544	1,979,333
1920	69,118	0,789,317
1921	66,125	0,757,156
1922	64,956	0,688,195
1923	96,348	1,086,138
1924	114,856	1,330,404

According to a report [25] on the trade for 1917 by the American consul at Hankow, 10,500,000 lbs. of vegetable tallow valued at $1,400,000 were exported to U. S. A. In 1908 white tallow was sold at 10 to 11 teals a picul but in 1917 the price was raised to 13.50 teals. Stillingia oil is exported with other vegetable oils. So no definite data of the statistics can be found, but we know that besides exporting to other countries a great quantity of it is consumed annually at home.

The chief consuming centers are Great Britain, Germany, Denmark, the Netherland, Sweden, Italy, Belgium, Russia, Japan, and America.

From the data given above, we can realize that vegetable tallow and stillingia oil have a good marked. But the quantity exported decreases yearly. This is probably due to price and quality, so in order to keep on the trade, improvements on the methods of production and the quality of the oil are urgently needed.

The following table shows the net profit that can be gained in running the business.

TABLE XVI(26)

RECEIPTS		EXPENDITURES	
	coppers		coppers
Vegetable tallow 360 catties ..	12,960	Stillingia seed 120 tou	10,000
Stillingia oil 320 catties	12,800	Wages & Board for 12 mill hands	1,000
Stillingia cakes 400 catties ..	800	Wood 100 catties	100
	26,560	Misc, expenses fodder, tools etc ..	1,500
Expenditure	20,600		20,600
Balance	5,960		

The net profit from 4 hours' operations, amounts to 5,960 coppers or nearly $20. It is by no means a bad business.

SUGGESTIONS FOR THE FUTURE DEVELOPMENT OF THE INDUSTRY.

Judging from the various uses discussed above vegetable tallow and stillingia oil will soon occupy a very important place in the world market should improvements keep pace with its increase in usefulness.

1. Methods for cultivating the fruit and the tree should be improved. Practically no attention has been paid along this line. The trees mostly grow wild by themselves. If we can plant them in better conditions, no doubt, they will produce better and more seeds.

Besides, the quantity of oil obtained from the seeds varies with the locality. Thus, the seeds from Soochow produce more oil than those from Hih Yu. So, in order to get maximum yield in oil, it is necessary to find out the conditions most suitable for their cultivation.

2. Better methods to collect the seeds should be devised, so that within a minimum amount of time, maximum amount of seeds can be collected and at the same time the trees are not damaged.

3. The present method of crushing the seed is too crude. Consequently, the waste is too great. Some simple machines ought to be devised for more thorough crushing so that the largest amount of oil could be extracted and quality of oil can thus be improved.

4. Better transpotation is needed so that the products can be distributed more easily and to a wider area.

5. The quality of the oil should be standardized so as to discourage adulteration.

6. Some systematic investigations should be carried on to study the seeds and its products so as to find out more and better uses for them.

Outlook for the Industry

The future outlook for the tallow and oil is a promising one. Should proper driers be found, stillingia oil can compete successfully with linseed oil and China wood oil. As the trees, though abundant in China, are not cultivated in other countries, it is a good chance for our people to create this industry. It would be unfair if we still regard stillingia oil as simply an illuminant or as an adulterant. The day will soon come when our people will appreciate more the true value of Stillingia Sebifera and its products.

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陳氏電氣號誌及機車時計表說明書

著者：陳崢宇

電汽時計表之構造歷史與原理

頃年以來,國內鐵道,每遇危險發生,車機兩處輒互相推諉,以致不能詳細查辦.每日各站出進車輛之時間與數量,又甚不精確.茲爲補救此種問題起見,創製此種機件.考余初創之機件,爲機械式者;利用號誌重量,加於打字鐘盤,印於活動紙板上.此後號誌上昇,利用反動力,再加於打字鐘盤,印於活動紙板,卽可知放昇號誌之時間.同時機車進站,由車觸號誌桿,傳力於打字鐘盤,卽可知機車何時進站.同時又可知其進站若干車輛,由此推想,改用電力.由鐘盤機械上裝一圓形銅筒,其表面裝有印好之時計日份牌.每日由站長更換一紙.其下有六電圈.每圈內有軟圓鐵一根.距此圓鐵有小方鐵,連於指針銅片上.此銅片上端爲指針,指針爲小匣,內含各色油棉,以代筆.電圈一端經過電瓶,再由電瓶連於號誌鈎.他一端則由電圈連於號誌環.號誌放落,則鈎環接觸,電流相通,名之爲號誌輪道. (Electrical Cicuit for Aimaphore) 電流經過電圈,則發生電力感應,圓鐵棍變成磁鐵,引動小方鐵,將指針放於鐘筒上.鐘筒自轉,則指針畫成紅直線.如號誌昇起,則鈎環離斷,卽電流不通,故指針亦離鐘筒;而鐘筒紅線所標之時間,卽號誌放落之時間也.

第一道及第二道均同此理.不過站南北各兩道號誌,共用二線,卽可應用.此外列車輪道,(Elec. Circuit for loco. and train) 卽在二軌接頭處,開口各二端,連以電線.車機通過,卽生暫時電流.此電流通過電圈,感應磁鐵,由磁鐵吸引方鐵,卽將綠色筆印於日份牌.列車行內,卽知進站爲何時間,同時吾人知每機車,每邊有前後各二輪,卽知每車爲四點.反之卽每四點,爲表示一車輛之數目.如邊輪爲二,則知爲普通車輛.但印點距離總爲一定,由此可知其經過有

若干車輛.且每日統計,即可查得,共有若干列車通過,與車輛通過總數,法至善也.

電汽時計表測量機車進站及經過車輛數目之方法

按時計表測量機車進站及經過列車數目,其法有二.一即連絡兩電線於不通電之二軌端.此法甚爲簡便,但計算車輛以每車邊有四輪,即爲四點,即知爲一輛車.然不易精確.其二即爲每車有活動絃居車頂上,如過號誌,即觸及號誌垂弓.垂弓端接觸固定銅片,則電流通.即印一點於時計表,同時若干點即可知爲若干車輛也.其聯法與號誌聯法同.

電汽計時表之功効

由上述之理論及計劃觀之,此表功效如下:

(一) 每次號誌昇放若干時,可得確實之記載. (二) 每日號誌共放若干次數. (三) 機車及列車於何時進站. (四) 每次共進車輛若干. (五) 每日共經過若干列車. (六) 每日共有若干車輛經過. (七) 當日車機兩處,有無不合法之事實發生. (八) 危險事實發生,應由何方負責. (九) 車站號誌人員,是否遵守規章及其勤怠. (十) 減節號誌人員,及減省不確切之報告與時間.

電汽時計表之應用

機件每二星期開發條一次.日份表每日更易一次.舊表紙由站車呈段長轉處長保存.電瓶及機件如不良時,可由電匠整理之.指針頭務須潔淨,油棉顏色務應鮮明.機匣鎖應由站長負責保管.此機應放置站長房或電報及路簽房,以便辦公順利,而電信及路簽亦可收協助效能,則此後車機之危險,庶可減少矣.

機車鍋鑪之檢查及其修理(續)

著者：張蔭煊

(十五) 外火箱相及圓筒部各鈑 Wranped Sheets & Barrel Sheets 之修理　圓筒部各鈑之厚度限點,依理想可舉一例如下:——設有一鍋鑪"T"爲鈑之厚度,"P"爲每方吋之壓力,"D"爲鍋鑪之直徑則鍋鑪鈑所受之拉力,爲 $F=\frac{DP}{2T}$ 若S爲鈑料之破斷拉力,則保安系數爲 $\frac{S}{F}$.今以保安系數"5"爲標準,觀其最低之厚度如何.惟通常厚度減至 5/16" 或 9/32",須更換之.鍋鑪圓筒部因廠面銹蝕,其補塊須覆在內面.此種乾補塊 Dry Patch 足免去劣水之再度消蝕.其厚度常爲 5/16" 或 3/8".在燒熱時覆上,並記出其位置,照 W. J. Bennet 之補法,消蝕處,須洗淨,麻蕩塡以紅鉛及細鑄鐵屑之混合物,外塗紅鉛漆油,而後覆上補塊,用燒紅鉚釘鉚持之.至於螺栓釘 Bolt 則不適用也.

補塊決不能用以覆蓋裂縫之處,蓋裂縫雖蓋沒,但鍋鑪之或伸或縮足使此裂縫仍繼續在補塊下擴大.故鍋鈑之有裂縫者,宜拆換之.其相接合之鈑面,須潔淨無鐵銹之存在.Webb 常主張清洗之後,漬以 Sal Ammoniac Sol: 至於利用哼沙 Sand Blast 清洗,亦無不可.兩鈑相接時,設鉚釘之直徑爲 d,自鉚釘中心至鈑端距離常爲 1.5 d+1/16" (日後老鉚釘孔須續漸削大,故此距離決不能小於1.5 d)

外火箱鈑常爲修換螺撐,其螺撐孔逐漸增大迨過度時(例如 1/14" 以上),若此項大孔數甚多,則必割換新鈑.若其數尙少,可鑽大孔眼塞進墊圈,用原本直徑之螺撐以旋入墊圈中.

外火箱喉鈑 Throat Sheet 及背鈑等左右轉角處之一直立排螺撐孔間,常有裂縫發生於內面(着水面).輕微者.治以電銲.甚者,治以補塊.其尤者,則換新.至於外面銹蝕,亦可以同法治理之.

(十四) 火管 Fire Tube 之装拆及修理 今日火管有四種:鋼質,鐵質,紅銅,黃銅.

鋼管係冷軋 Cold Drawn. 絕銲 Weldless 而爲最優等之開心鑪鋼料.依 B.E.S.A. (British Engineering Standard Association)之標準,鋼管須(1)光滑完整,絕無裂縫鐵銹.(2)兩端須整潔平直.(3)重量須較推算者(489 lbs/lcu-in.) 高出 2 1/2% 至5%.(4)拉力不得少於 24 T/D'' (54000 16 5/D''), 伸長不小於 28% (8''). (5) 管之全部須經軟煉 Annealing 其平均厚度如下: 1 3/4'' 管 —12 S.W.G.; 2'' 管 — 11 S.W.G.; 2 1/4'' 管 — 10 S.W.G:.

鋼管之利爲: (1) 價廉. (2) 有抵抗今日最高鍋鑪壓力之力量.其弊爲: (1) 傳熱不若紅銅或黃銅管之佳良.而易於銹蝕,麻面銹蝕 Pitting, 並在火管鈑內不能如紅銅及黃銅者之緊接.搭銲之鐵管 Lap Welded Iron Tube, 今日已不甚用,昔時之標準,爲: (1) 須用上等煉鐵製造. (2) 兩端須經軟煉 Annealing.(3)拉力在 19 T 至 24 T/Sq. in.之間.截面縮小,不小於 45%.鋼管能鐵管須經水力試驗.鋼骨之壓力,須達 1000 lbs/Sq. in.鐵管之壓力, 750 lbs/Sq. in. 同時再須經 Bulging, Crushing, Flattening 等試驗.

紅銅火管,依照英國之標準,爲:(1)紅銅 cu 不可少於 99% AS 不少於 0.35% 至 0.55%.(2)須忍受漲大兩端直徑較原直徑大 25%, 而不發生裂縫.(3)須忍受摺撓至較大於原直徑 40%.(4)須經 Flattening 及 Doubling Over 等試驗 (冷或熱).

紅銅火管兩端之須軟煉與否,已成問題.昔時英國之標準,須軟煉.而最近 George Hughes 曾云,管頭不必軟煉,可任其全部"硬"或"半硬".若一經軟煉, 其軟硬之分界處,成爲弱點.因而管即斷裂於彼處.事實上,紅銅管,常於火箱附近損壞.似爲 Hughes 之極強理由也.雖然,紅銅過硬,在漲口時,管頭有裂開之虞.

紅銅管之厚度,平常 1 3/4 管 — 12 S. W. G. 者在火箱近端之一呎,其厚度

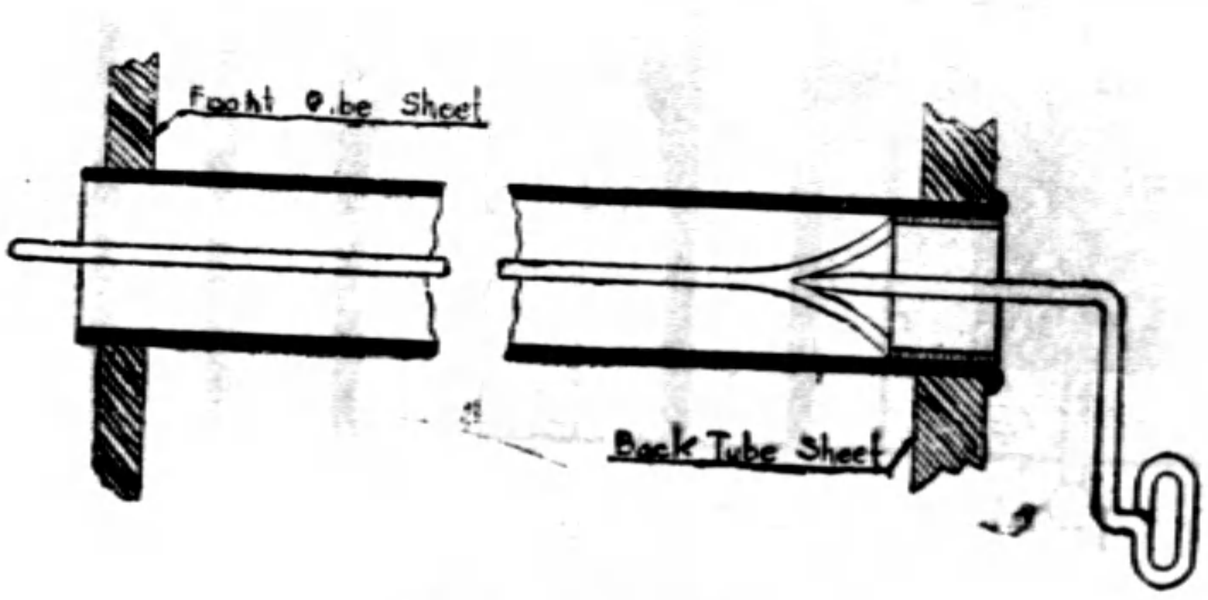
爲10 S.W.G. 自此斜下一吋六吋後,方爲厚度12 S.W.G. 近烟箱一端之三吋,其管孔之直徑,常大出1/16",以適合烟箱端較大之孔..Webb曾經長時間之考察,知紅銅管在近火箱之六吋內底部,常爲消蝕.以致開裂 Webb 氏,遂作一給證云.『此項不均勻之消蝕,或由於升火時, Sulfurous Acid (煤中硫質),凝於骨底之故.或由於飛颺煤屑擊於管頭護圈 Furrule 之頂內面,而復折於底部,以致消蝕也』.

黃銅管含CU—60—70%,ZN—33—30%,並至多可和雜3/4%之雜質.其Drifting試驗,與紅銅者無異.惟Flanging試驗,祇許大於原管直徑25%.他如 Flattening, Doubling試驗均相同.

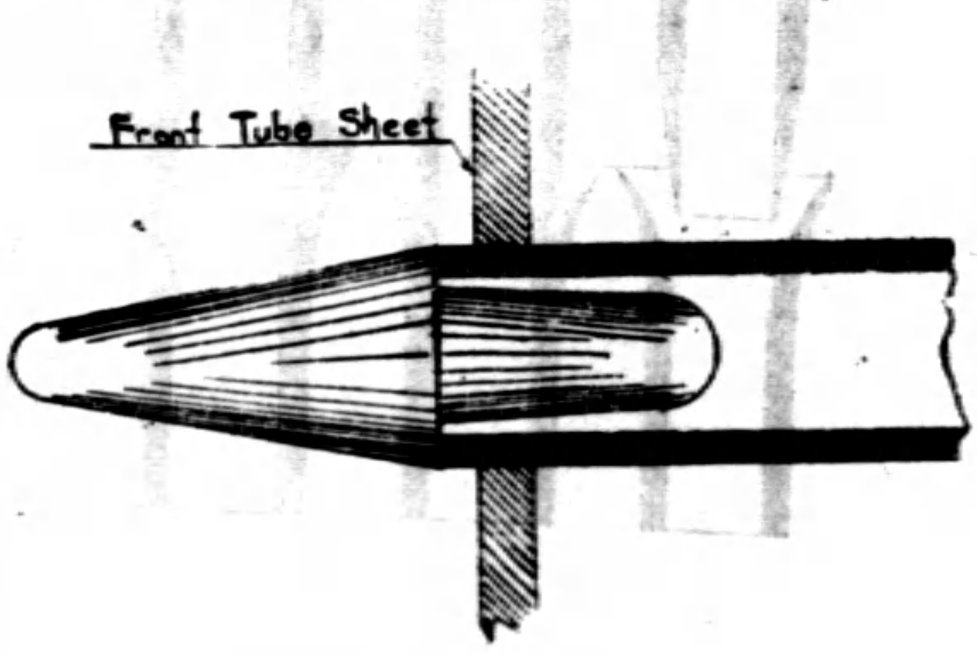
黃銅管之利爲:(1) Incrustation 水垢不能附着,如鋼鐵管之緊牢.惟不能緊漲於管鈑.且破裂之前.一無警告之現象.常突然而出.

鐵鋼管,常接銲兩端以紅銅,或黃銅頭.俾得與管鈑緊接,惟此法,於重裝管時行之爲妙.(因此時管鈑孔經歷次漲大已大增其直徑). 爲免除管鈑漏水(因管漲縮而在鈑孔內移動)、灣曲管曾大顯功效.蓋如此漲時,可灣曲Bend而不致伸出管外矣.

抽拔火管,須先撤去護圈,或墊圈 Ferrule. 其法可以長桿如第二十二圖擊出之.護圈棄去後,將管頭擊向內轉(用魚背鏨Fish Back Chisel). 又如第二十三圖以撤管器將管擊向烟箱端退出.迨烟箱端透出直當之長度時,即抽出



第二十二圖



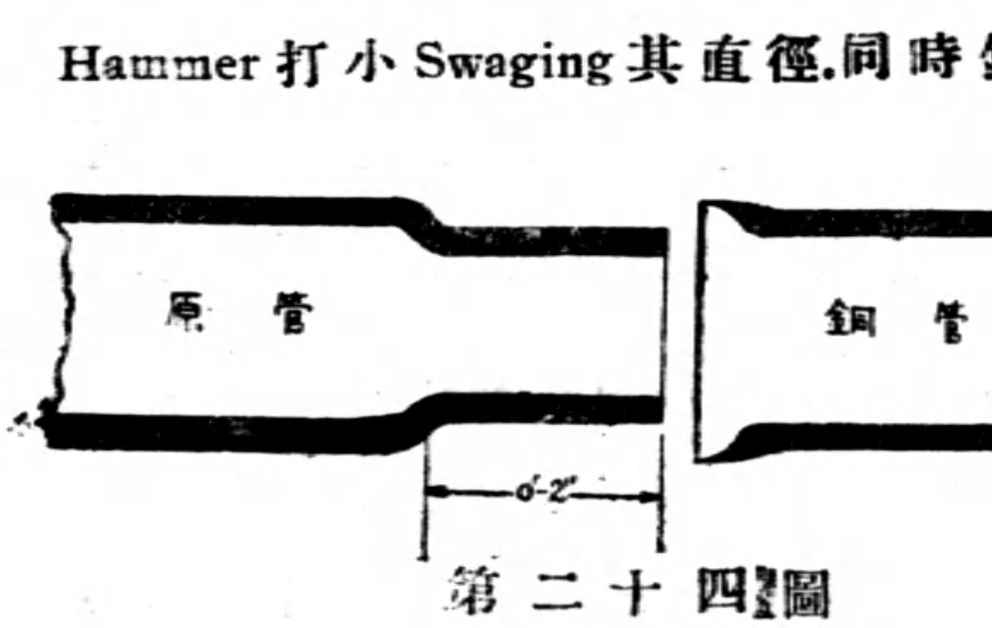
第二十三圖

之(烟管鈑孔較火管鈑孔爲大).有時亦可將管頭割去,而後如上法抽出之.抽管時,最宜注意之點,不可使管鈑上受任何刀紋,因此項刀紋,爲出險之源.

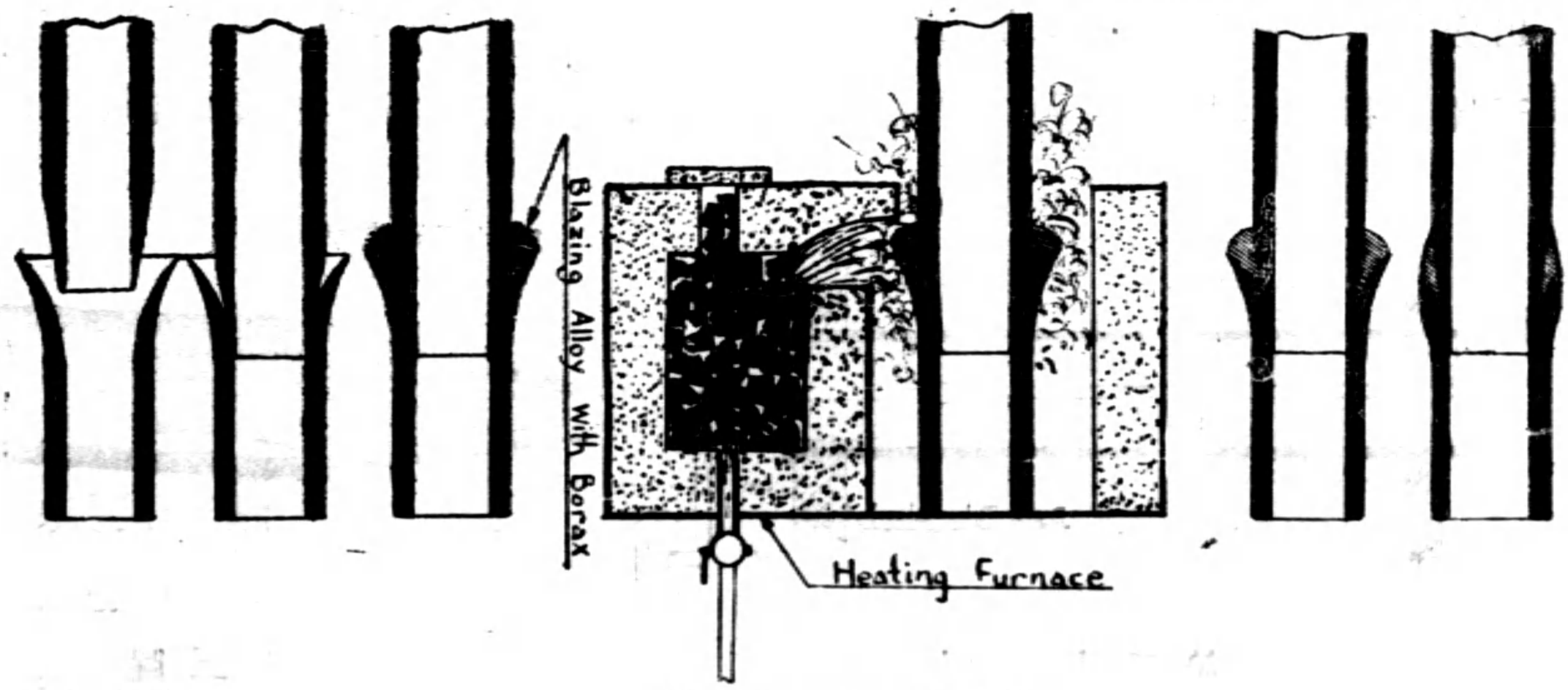
今日大多鐵路,用紅銅及黃銅管者,將拔出之管,投入鹽酸液HCL.十八小時,以去棄積垢,而後洗淨,乾之.以防養化.同時查驗之,並權其輕重,以定去留.

鋼管由鍋鑪內抽出,其兩端必損壞.且此等管頭,因歷次之漲大,質殊堅硬,決不能再爲漲大.故必割去之,而銲上六吋長之新頭(漢平用 10"). 至於割截之處須割成錐形 Tapered,銲上之管,須漲大其口,而後互插鑲銲之.銲成之管,可取 10% 硫酸液 H_2SO_4 Sol. 將接銲部沉沒於此液中.若佳者,其消蝕必均勻.否則必偏於銲之部分.

今日大多鐵路常於鋼管上銲接黃銅管.如此則原管兩端,須用 Pnenmatic Hammer 打小 Swaging 其直徑.同時銅將管頭割成鐘形 Belled, 而鑲插原管如第二十四圖.至於接銲紅銅及黃銅管,其手續相同.惟各管銲時.雄端Male End宜先以粗銼磋出毛紋,俾銲接部分,能牢固.銲後須經"水壓"試驗.雖然,此項銲

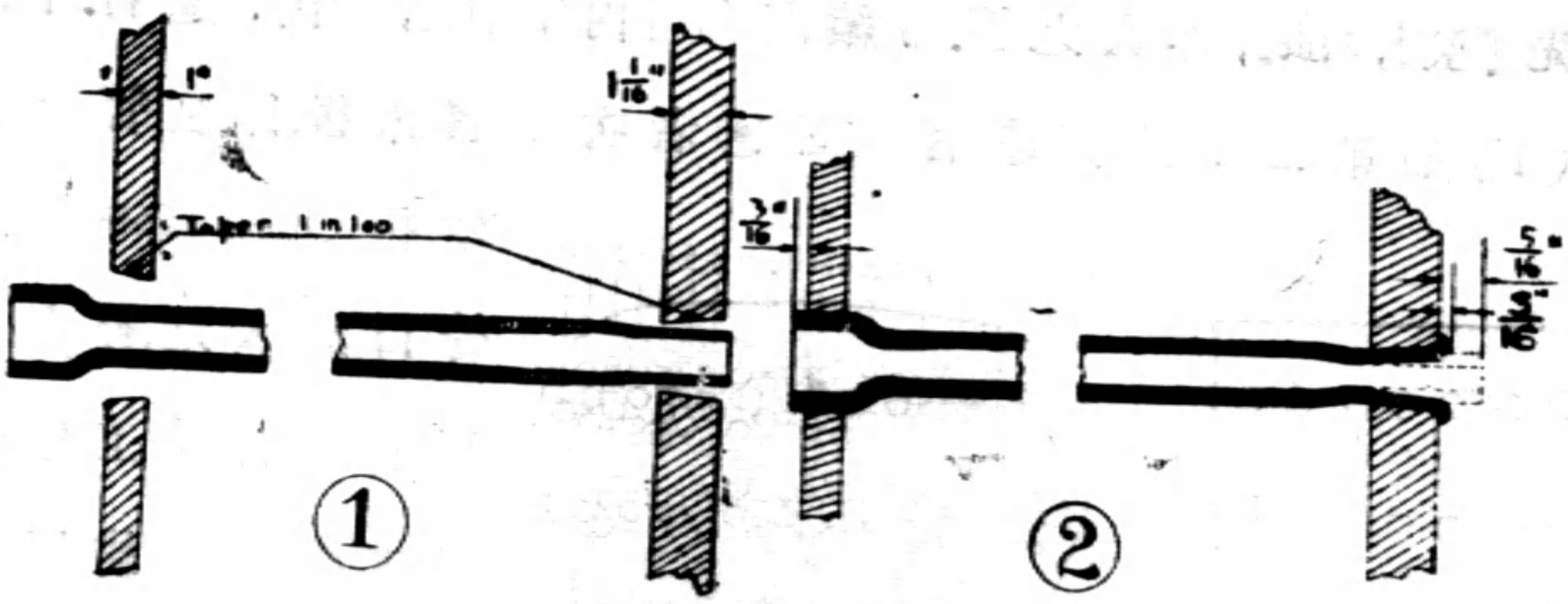


第二十四圖



第二十五圖

管,往往出險.宜割短之而用於較小之鍋爐.第二十五圖爲漢平鐵路,對於普通鋼管接銲之情形.第二十六圖(1)爲歐洲普通所用之平安式Safe Ending,一端接銲紅銅管於鋼鐵管之狀況.(2)爲此式火管裝好漲大管口之狀況.

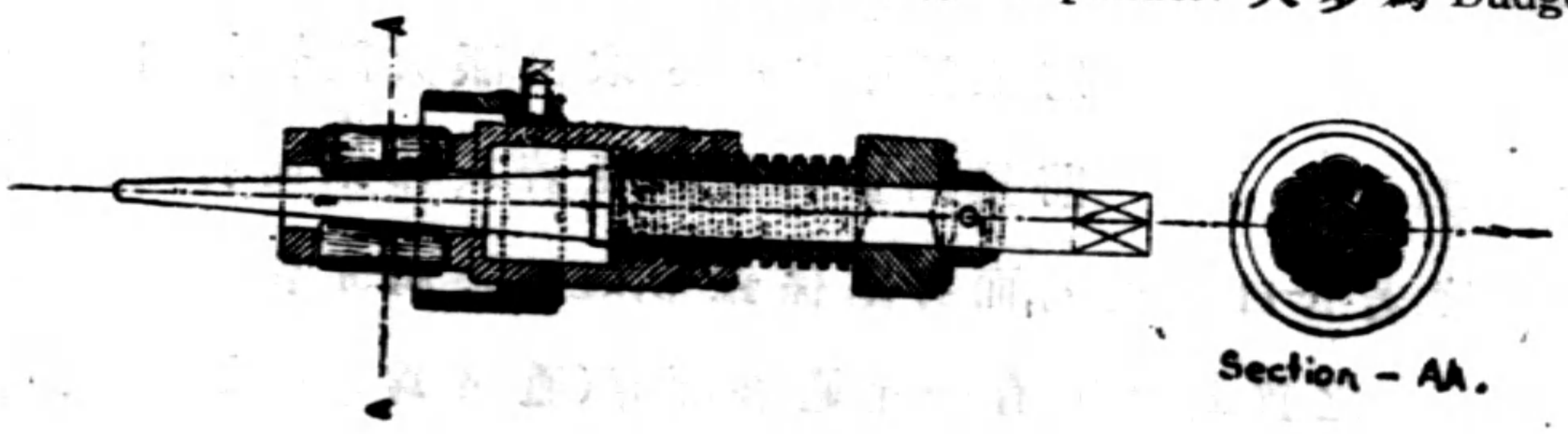


第二十六圖

紅銅或黃銅管之損壞,可劃去兩端損壞部後,用伸管機伸長之.今日歐洲對於鋼管,竟亦用水力伸管機伸長者.例如 15'—6" 之管,可伸出一呎.十一呎長者,可伸出6".

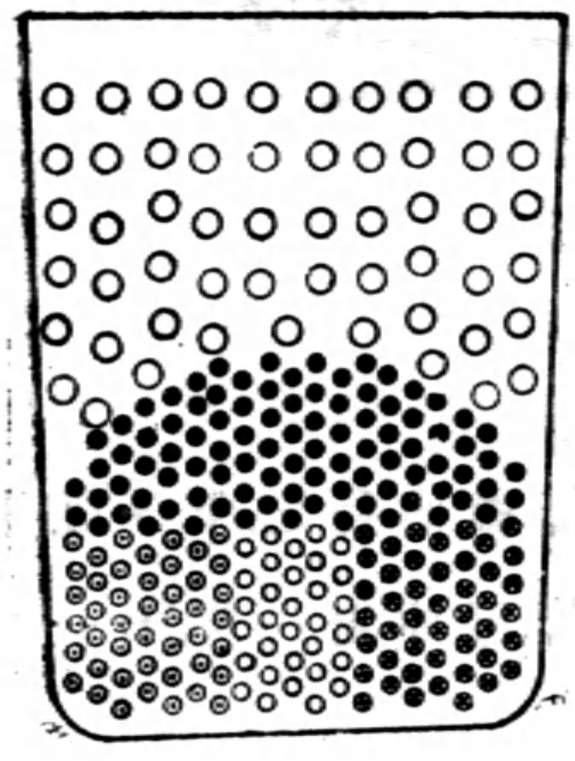
裝管工作之次序如下:(1)插管 Mounting. (2) 漲管 Expanding. (3) 圓轉 Beading.裝管之前,必先將管上之銹及硬鐵皮 Scale 去棄之,俾得緊接.裝管之法,將管由烟箱一端插入.同時火箱中另一人,在相當鈑孔內伸入鐵桿,以爲該管之引導而後在烟箱端將管擊入後火管鈑孔(如第二十三圖),至兩端透出自 3/16" 至 1/4".

漲管時,大忌用挺桿 Drift. 須用漲管器 Expander. 且須由鍋管鈑之外邊而漸入於內部.又不可偏於一邊.漲管器 Expander. 大多爲 Dudgeon Expander 如第二十七圖.普通有三轉棍 Rollers,最近查知此式(三轉棍者)

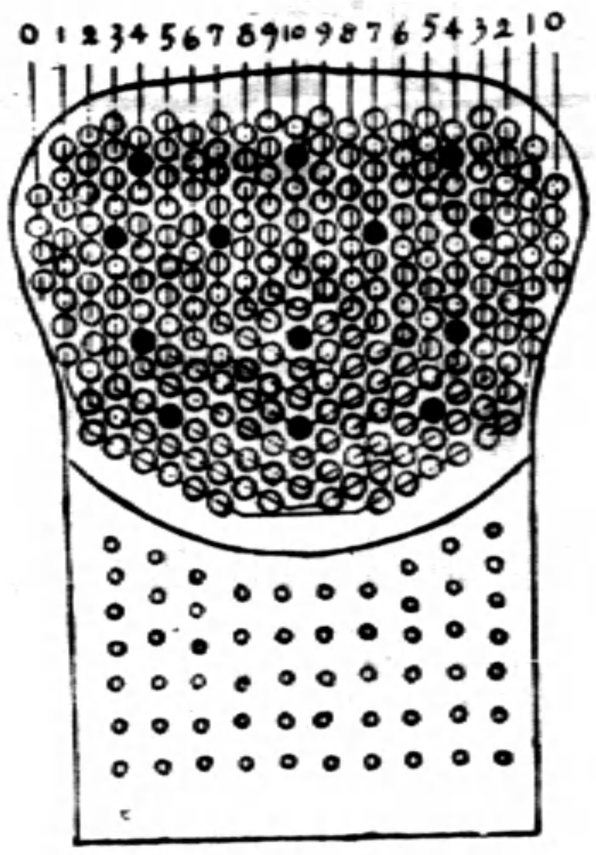


第二十七圖

與管壁之接觸點,距離太遠.漲管時起出波浪 Wave 動作,管形略有三角現象,以致漏水.職是之故,今日多用五轉棍或六轉棍者（我國鐵路大多用三轉棍者,亟宜改良）. 裝置新管,爲免除管鋼之受損 Distort, 有種種裝法,其主旨不外先『裝』,『漲』,外底之管.而續漸向『內』,『上』,『中』, 進行.今以二法列下:——(1)如第二十八圖●者先,⊗ ⊙者次,○者末後.每裝管三排,即將離空孔 Open Hole 最遠之一排管口,漲大之.終之在漲管時,須於空管及工作管之間留出未漲管二排,以防管孔間之裂開.(2)如第二十九圖,●者先裝而漲之.自後以次由 0, 1, 2, 3, 4, 順序而下,至10而止.

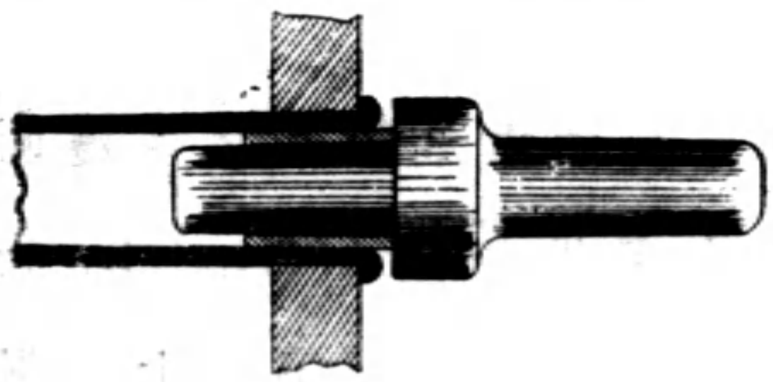


第二十八圖



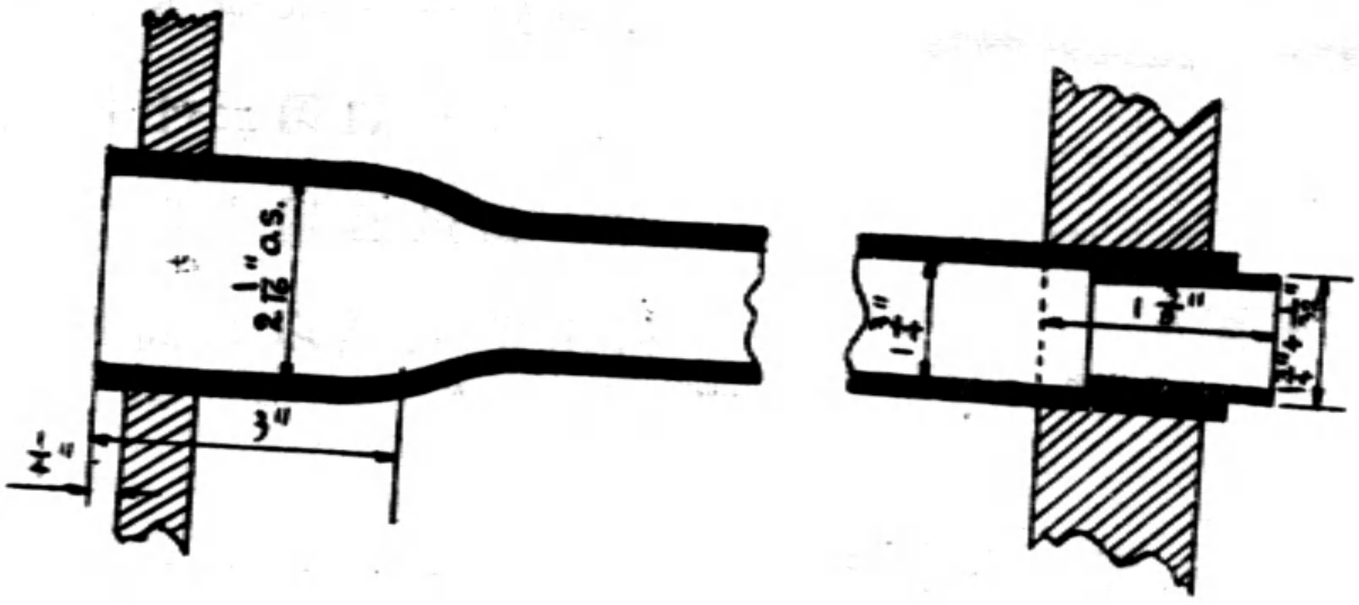
第二十九圖

墊圈 Ferrule 厚 1/8", 常用於二次裝管時,墊於管孔及管壁之間,以抵消前次管孔之漲大部份者也.而黃銅紅銅管之內壁,常襯以此項墊圈者,所以免灰屑之括蝕,寓有保護之意也.有時內墊圈之圓轉者 Flanged Ferrule, 所以保護圈之圓轉口也.第三十圖,爲打緊墊圈 Ferrule, 於紅銅或黃銅管之狀.欲打緊管內面之墊圈 Ferrule, 若於熱鍋時行之,足撓曲或凸起鐴圈皺.故打緊之前,須將原墊圈 Ferrule 取出,漲大該管管口,而後將墊圈重行打入.至若於冷鍋時打進墊圈,須注意管口之損壞.若管口係直行,而打塞係錐形,則結果祇足使口緣緊漲.故管口及墊圈 Ferrule 之錐斜度,須有一定適合標準(通常爲 1/05 或 1/40). 英國墊圈 Ferrule 常爲鋼質長 1 1/8" 至 1 1/4", 厚 3/32". 有時亦有長 2".至於烟

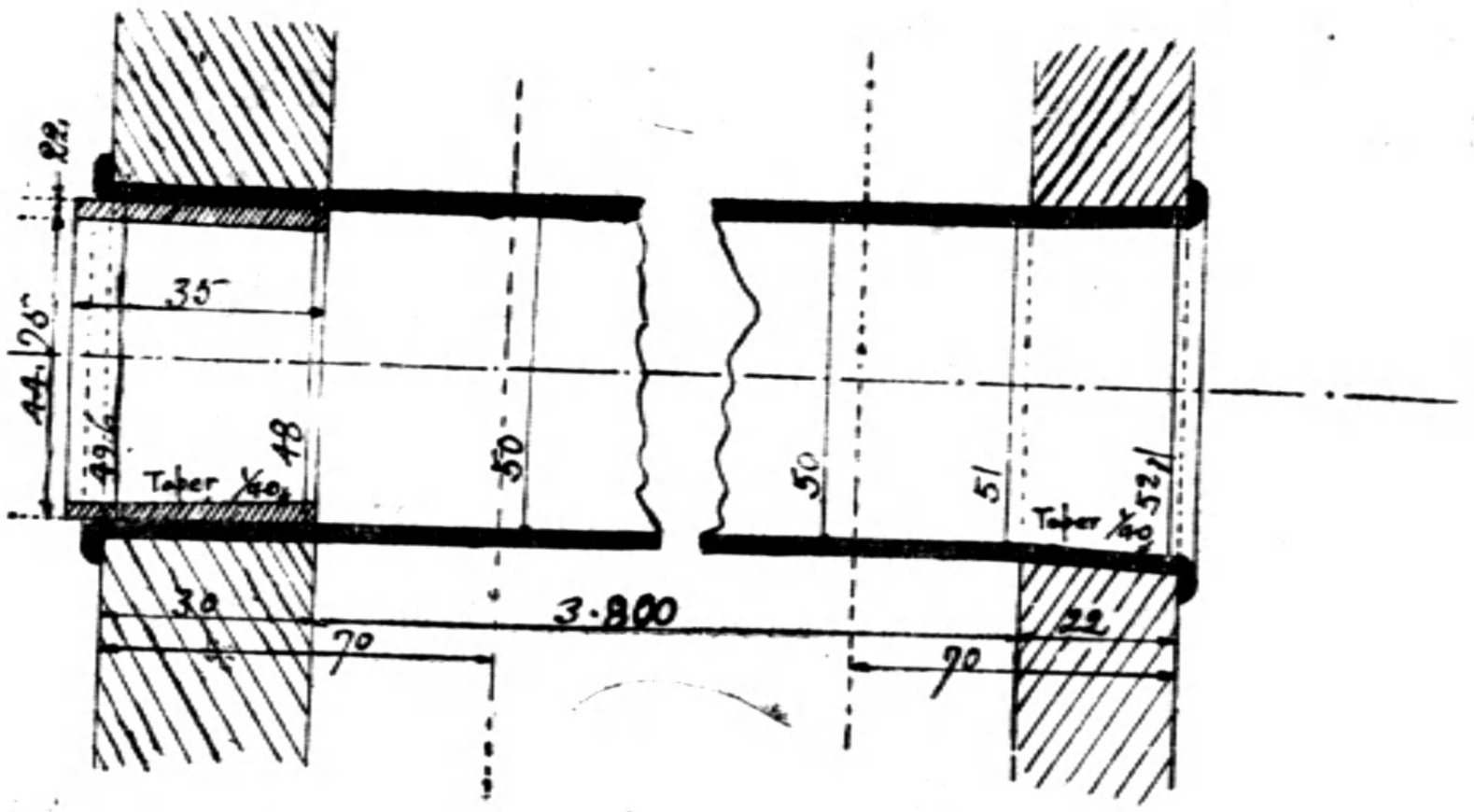


第三十圖

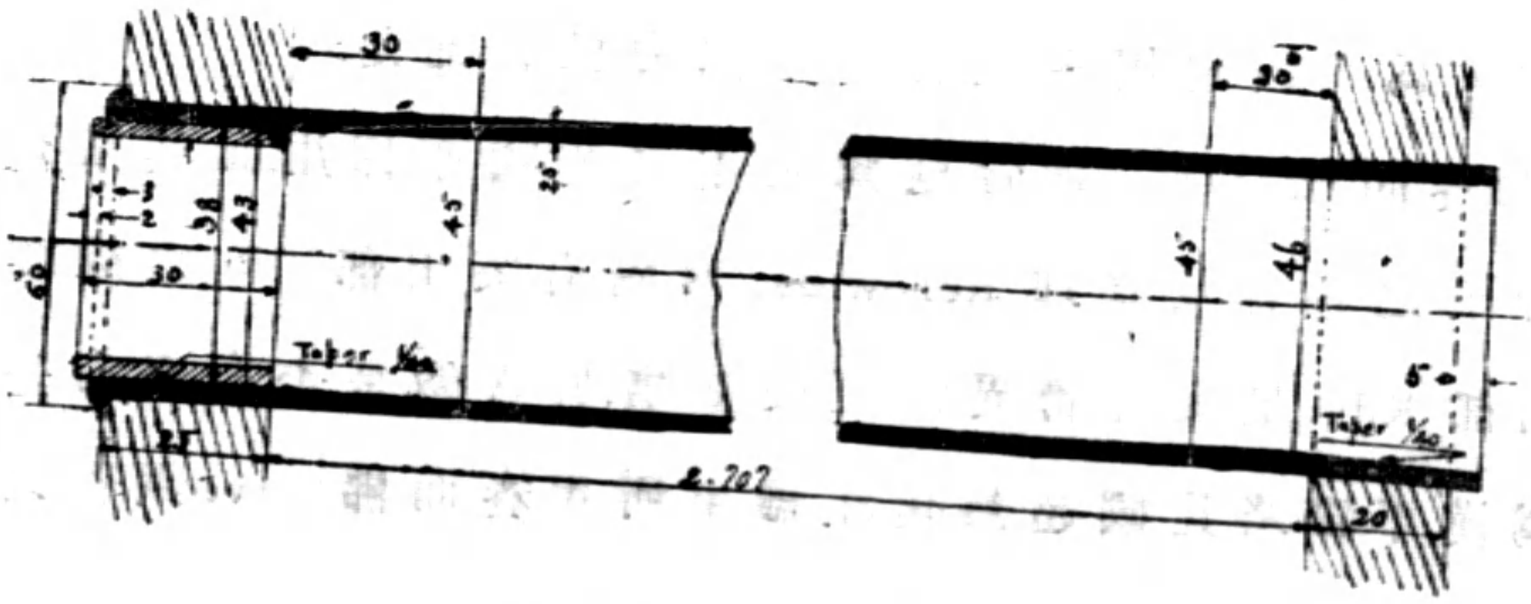
箱一端,則僅漲大管口而已.不用墊圈.第三十一圖爲英國常用之黃銅管頭保護法.第三十二圖爲漢平鐵路法國社會式機車黃銅管頭用鋼護圈保護之狀況.第三十三圖爲漢平鐵路比國合股公司式機車黃銅管頭用鋼護保護之狀況.美國對於鋼或鐵Charcoal Iron管,常先襯一薄墊圈於管孔及管之間,而後漲大管口.如第三十四圖(a)爲伸進之狀.(b)爲漲大之狀.(c)爲圓轉之狀.火管火箱一端漲大後,用轉管器Beading Tool圓轉管口於管鈑之上.昔時有先以Drift打成管口形,而後圓轉



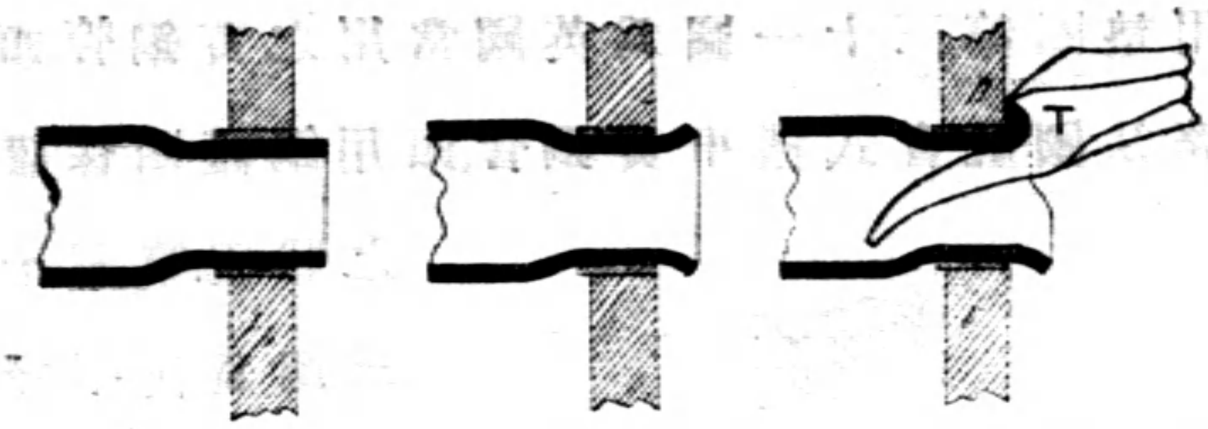
第三十一圖



第三十二圖



第三十三圖



第三十四圖

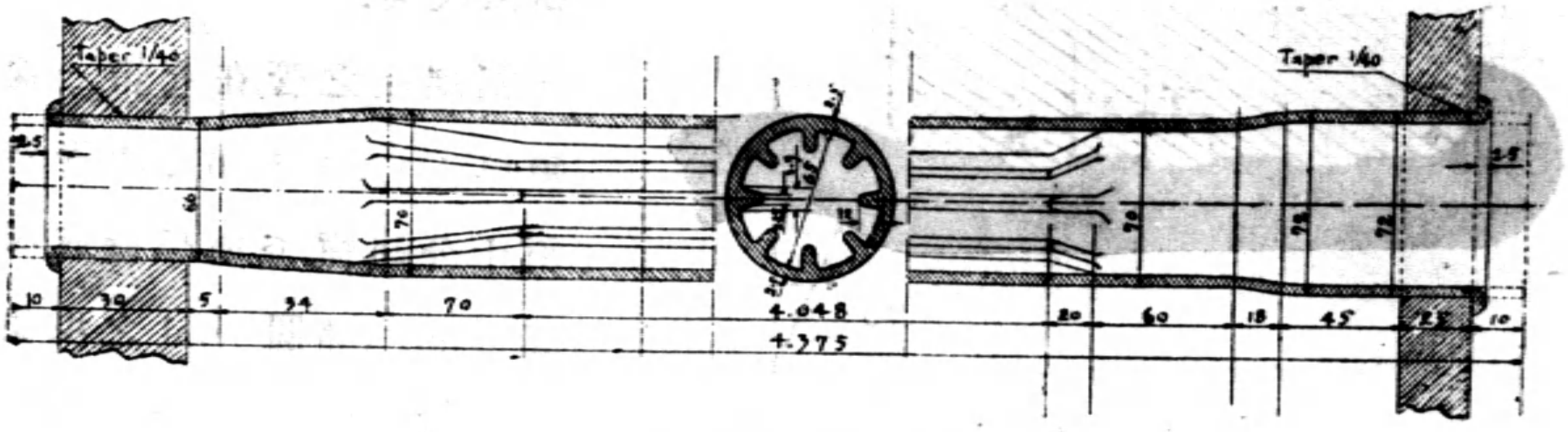
之者.今則知此不佳,已不復應用.至於烟箱一端之管口,則不加圓轉,祇漲大而已.圓轉之器具,如第三十四圖之"T"爲最普通之器具.至於利用壓氣錘以爲圓轉管口者,今日歐美頗盛行之.

新管在圓轉管口後Beading,經燒用,圓轉處常離開鍋管鈑某種距離.爲是先用一種器具有45°之錐形者,在漲管後使管口略包轉鈑外,經燒用6至S星期後,此管與管鈑必已互相衝突完畢.遂圓轉之Beading Over. 如此漏水之弊,可減少也.第三十五圖 (1)爲普通鋼管之裝法. (2)爲一種堅固而新式之鋼管裝法.大多鐵路,亦有將管口附近在螺紋機上Screw Machine, 用割螺紋機械割出紋路Groove深1/64"闊3/32").插入管鈑,而後用漲管器Expander漲大之,使紅銅深入紋路 Groove. 此於焰管所常用也.

第三十五圖

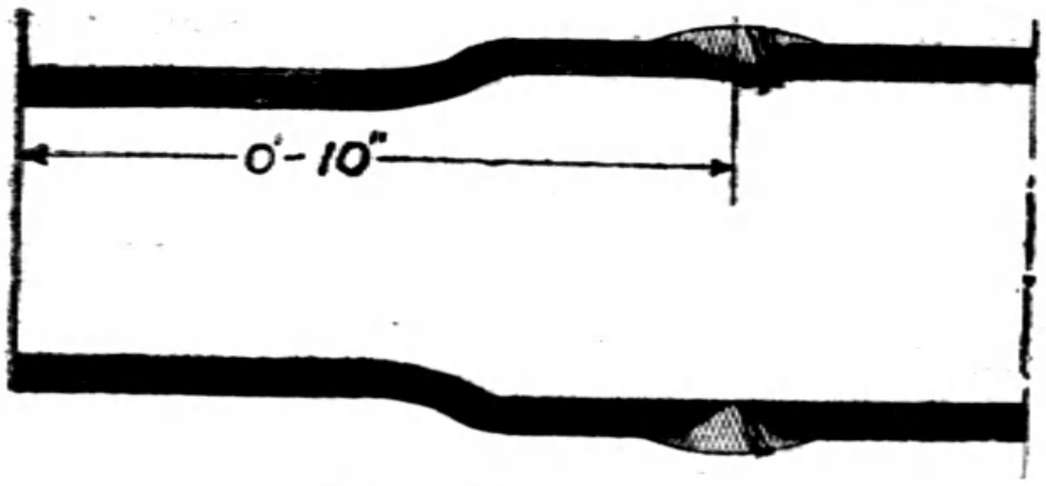
火管於管孔間所受之緊握力隨其所受之工作而變設火管緊插入管鈑孔則管與管孔間之牢固力爲1.漲大管口,而鑲入護圈,其牢固力當爲2.若再圓轉之,其牢固力又爲5.但實用上漲管之牢固力已甚充足.

內有突出部Rib之賽而佛 Serve 鋼管,法國廣用之.英國亦採用.而其價值之貴,固可不論.其管頭之鑲合及修理 Renewing, 因內有突出部 Rib 之故,甚爲困難.且此項突出部 Rib, 足使管體異常挺硬堅實.於管鈑是否有害,尚是疑問.第三十六圖爲漢平鐵路比國超熱複漲機車所用賽而佛Serve鋼管之裝法.

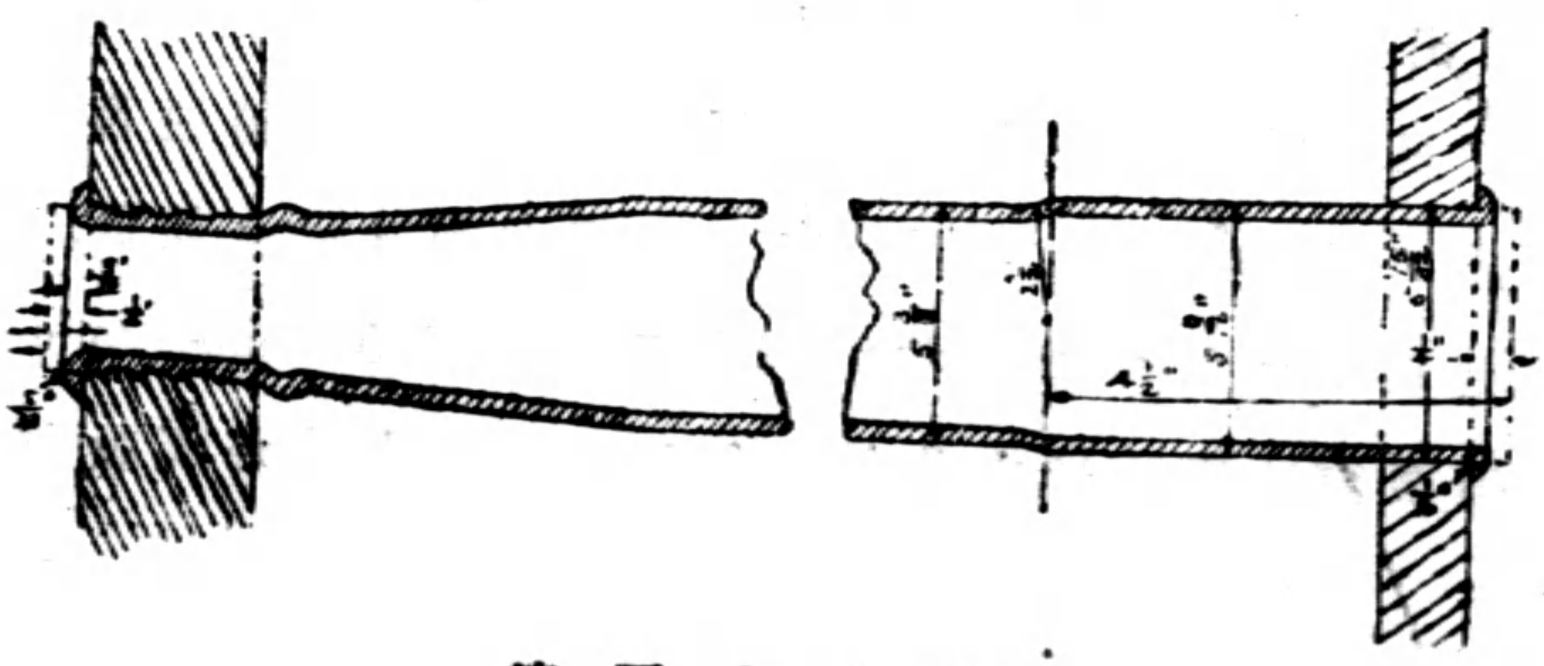


第三十六圖

(十五) 焰管 Superheat Flue 之修理　煙管常可於安全中由鍋鑪內抽出.惟管口屢經漲大,質性變硬,往往不能再行漲大及圓轉,因之兩端常割去 6 吋至10吋,管上新頭(與小管相同).近年漢平鐵路,對於此等煙管新頭之接管,則利用電管,效果甚佳.第三十七圖爲該路銲煙管之情形.該管裝置之法,約有數種: (1) 管鈑着水面可作出肩架 Recess,而火箱一面包轉之 (2) 割出三四紋路 Grooves 於管口附近(已如上述).如此因其直徑之大 (4 3/4'' 至5 1/2''), 漏水之弊,仍不能免.故今日多割出螺紋(英國用每吋十一螺紋距) 旋進於管鈑矣.惟螺紋管頭旋入管鈑經燒用,不復能旋出,亦必割去銲上新頭.同時管孔亦須重割螺紋.第三十八圖,爲漢平鐵路美國羣固式機車所用煙管之裝置情形.第三十九圖爲該項煙管應行割切之



第三十七圖



第三十八圖

第三十九圖

切路尺度.

割螺絞之管,在火箱一端,須厚 1/4'' 至 5/16''. 漲管時,須十分謹慎.否則恐變成橢圓 Oval, (橢圓 Oval 之現象亦焰管主要病之一). 雖然螺紋管頭,亦不能免漏水,且常有螺紋斷脫現象.一旦發見,必抽出老管,將老孔削刮而重割螺紋,同時換新管頭,重行裝置之.

(十六) 超熱氣管 Superheating Elements 之修理 超熱汽管 Superheating Elements 之主要弊病,爲該管灣曲部之削薄.蓋此部受最熱之火焰,並高速率火屑 Cinder 之猛撲也.爲是此處常用鑄鋼尖帽.一旦發生漏汽.必更換之.此外煤中之硫質 Sulfur, 常使超熱汽管發現沙眼 Pin Holes 而漏汽.此則完全須更換.

雖然超熱汽管 Superheating Elements 之病,甚難尋覓.故每逢洗鍋,可撤去遮鈑 Damper, 而後注水於總汽管,由總汽管而超熱汽管 Superheating Elements,此時超熱汽管之病,可於發現出水之焰管而得之.

超熱汽箱 Superheater Header 在抽去火焰管時,常須撤去之.有時在機車廠 Loco. Shed, 亦有撤去之必要.且在直長撐桿 Longitudinal Stoy 之修理,此汽箱 Header 亦須撤去.同時出汽管 Blast Pipe 及遮鈑 Damper 等,均須撤去.取去超熱汽箱時,須以木楦二根,塞於附近左右適當之焰鋼孔內,脫去汽箱連着於管鈑之螺栓,而後在此二楦上移出.迨達烟箱中部,用繩索將其降至箱底.

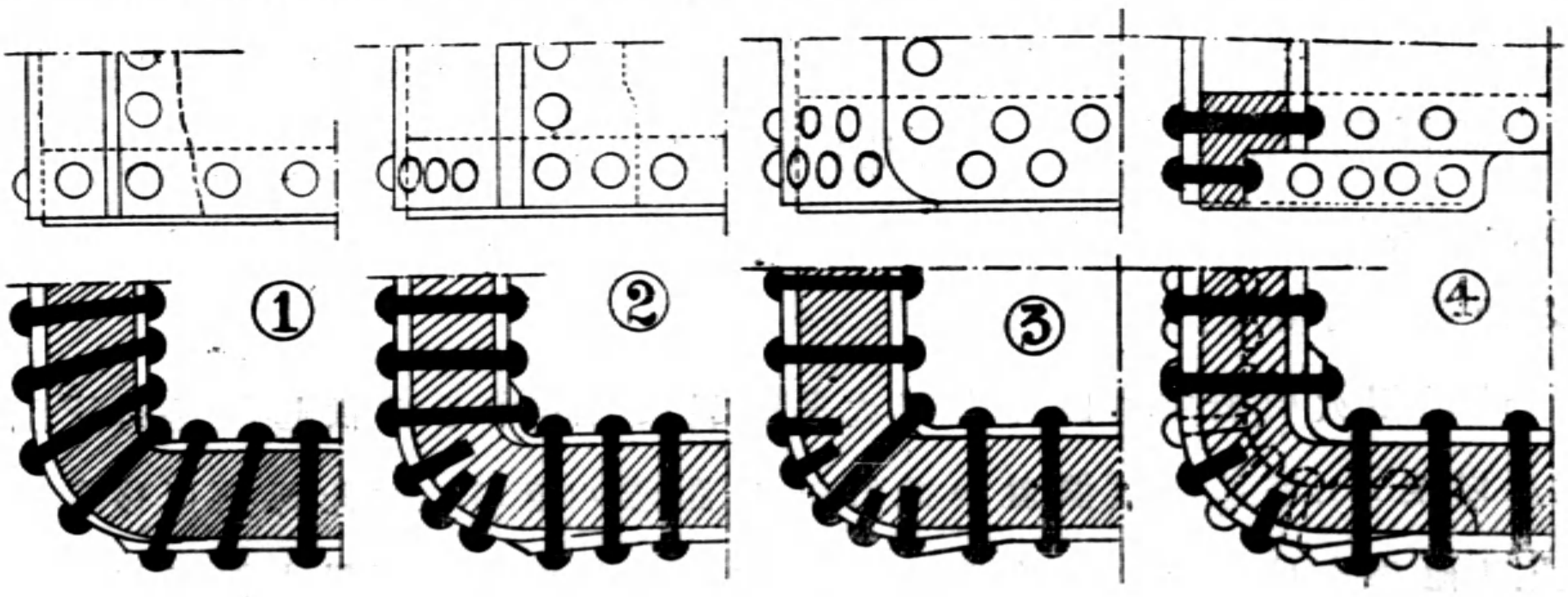
超熱汽管與汽箱連接處,亦時常發生漏汽,此大多屬於墊環 Copper Jointing Ring Washer 之損壞,須時常更換之.凡新紅銅墊環,在用之前必經軟煉 Annealing.

(十七) 底鐵環 Fonndation Ring 之修理 火箱底鐵環之材料爲煉鐵 Wrought

Iron, 低炭鋼 Forged Mild Steel, 鑄鋼 Cast Steel 等.煉鐵爲昔時常用之料,今則鑄鋼甚通用.其與各鈑緊着之面,須整確而與各鈑合適.老練之打鐵工,亦能打製之.但大多製造者,常用機器割出平直面,以臻適合.其闊度,常與水間相等,約三吋以上.凡內火箱鈑底,灣出少許者,可用較薄之鐵環.

鍋鑪壓力達 150 lbs/Sq. in. 者,其鐵環之鉚釘不過一排.而高壓自 180 至 200 lbs/Sq. in. 者,因轉角處用一排鉚釘,難於緊接,常代以較深厚之鐵環,用鉚釘排 (Staggered), 深鐵環於外火箱鈑底,有免除折紋之功效,蓋內火箱鈑之直二高向漲縮得均佈上部各處,而減低環上之撓曲也.

任何鐵環轉角處,因鉚釘之困難,常特別加深,且至少必有二排鉚釘（雖左右前後之中部爲單排). 鐵環轉角處鉚釘之困難,起於外火箱之轉角面較內火箱者爲長.外面鉚釘之距離 Pitch 勢必較內面者爲大,外鈑難於緊着,漏水遂起.且如此鉚釘之排式,甚不雅觀.若鉚釘與鐵環成直角者,此種困難,當可免除.故今日大部製鍋爐者,常使各邊之鉚釘互相並行,而於各外轉角面加釘紅銅或鋼螺釘,如此可免去轉角有鉚釘孔之存在,亦減少弱點之妙處也.第四十圖（1）爲單排鉚釘之小鐵環,用回射式鉚釘 Radial Rivet 者.足見其外角面鉚釘距離 Pitch 之特大.（2）.爲今日最合式之鐵環,鉚釘排其,法轉角用螺釘者.（3）爲雙排鉚釘鐵環,其轉角所用螺釘,互相垂直,角之正中,

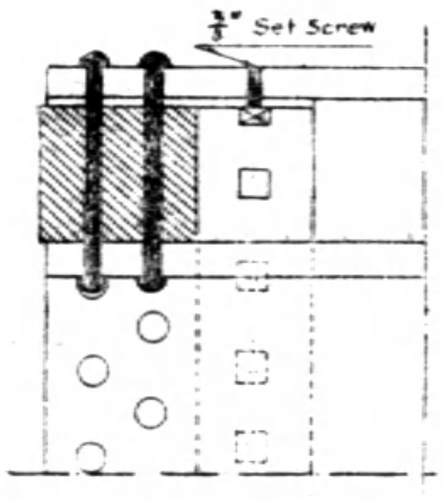


第四十圖

尙用一鉚釘.(4)爲別式之鐵環,其轉角特深 Deepened, 下排之鉚釘,祇鉚持一外鈑.

求轉角之佳良,必鑲合鍋鈑內覆蓋於外覆蓋與鐵環面之間.故內覆蓋之鈑端,必須打薄,將外鈑覆於其上,俾鉚釘連穿二鈑,而無虛隙.各鈑轉角一端.先燒紅撓曲之,使與樣鈑符合,而後鑲配於鐵環之轉角,用平錘 Flat Tool 擊之,務使十分平服於各該環轉角面(其他前後左右面亦如之).此步工作.甚爲緊要,若於鉚釘後覺察漏水,而欲擊服之,已不可能.蓋此時打擊,徒使此打擊部伸長,而愈增其漏水之趨勢也.

若底環伸出於鈑底外者,塡塞 Caulking 時,可用闊圓頤工具.與鈑底平齊者可用平頭塡塞器,以緊閉其接縫.至於內火箱鈑與底鐵環,亦以同樣之法鑲合之.火箱鈑底環附近之拆紋,常爲一種難免之病,須時常撤去水垢,而驗其折紋之損壞程度.欲免除此項箱鈑之折紋 Grooving, 可用 1/16'' 厚紅銅鈑保護之,如第四十一圖.



第四十一圖

(十八) 火磚拱 Brick Arch 之修理 磚拱之用,所以助益空氣與煤炭氣 Hydrocarbon Vapor 之調和,以臻燃燒之完全,而免墨烟擁塞於烟窗,並可免除冷空氣直由爐口衝入烟管也.其實際利益,法國曾試驗得之.大概磚拱遮蓋爐篦 2/5 者,較之無磚拱者,可節省燃料 8%.其較短者,可節省 6%.且無磚拱之火箱及火管等,在行程 40,000 至 50,000 公里後,必拆下修理.而其有磚拱者,可 150,000 至 200,000 公里.則磚拱之功效,更可知矣.

磚拱用火磚製成,有時亦有用火泥等製成者.其中心常拱起 4'',全部下斜 1/3 以至 1/4.普通磚拱擱置於托釘 Studs(距離 9'' 至 10'').如此磚拱可移動其上.其他尙有於螺釘 Studs 上擱一 1 1/4'' × 3/4'' 之鐵條,而擱置火泥磚塊於此鐵條之上者.

之鐵條,而擱置火泥磚塊於此鐵條之上者.

砌築磚拱之前,須用拱架 Center. 所用火磚,可取較大之磚塊.俾連縫較少,而生命亦較長.英國常以磚拱緊着管鈑Tube Sheet. 而美國常留一3''至4''之空間其用意有三:(一)拱頂之灰易於下降於爐底.(二)有利便於抽風Draft. (三)此空隙附近之蒸發量甚佳,故今日此項空隙,各鐵路多採用之.

美國常以磚拱斜擱於 3''鋼水管上,該管下端接連於前水間,上端接於門鈑爐口與箱頂之間.

磚拱時有燒燬之事,宜時常檢查,得燬壞之火磚,換新之.

(十九) 鍋爐試驗 Boiler Testing　新製鍋爐,或修竣之鍋爐,必經水壓及汽壓試驗.水壓試驗,可用抽水機注水入鍋爐,或鍋爐中滿裝冷水,而熱之.其主要任務,爲證明各接縫 Joints and Seams 之緊閉與否.雖然,鍋爐受 250 lbs/D'' 之水壓者,未必能安全的受汽壓 240 lbs/D''. 蓋水壓爲一種靜力,而汽壓復有動力之存在,其情形顯然相異.且冷水壓試驗時,各鈑管等多未稍伸漲,即熱水壓試驗時,其伸漲亦屬有限.

試驗時,安置鍋爐於手車Trolly, 而登臨一機車坑 Loco. Pit 上,俾各接縫及火箱內外各部,可一覽無遺.至鍋上各孔,須緊蓋,玻璃水表亦撤去.並須將汽水各閥關閉.惟鐘形汽管,及鍋鑪最高處之孔,在裝水時,須完全開放,俾空氣盡行逃出鍋外,不至囚禁鍋內.壓力表須用二具 (曾經與表準壓力表校對過),設中途損壞一具,餘者仍可供用,此時保安閥可不用,俾壓力之大爲增高.鍋爐滿時,緊塞各孔,繼續注水如前.迨壓力達乎工作壓25%至50%以上而止.惟50%, 在今日新式鍋爐上,似屬太大(指工作壓200至225 lbs/Sq. in. 者). 故今日歐洲普通規律,爲高出工作壓自70至 75 lbs/Sq. in. 昔時 140 至 150 lbs/Sq. in. 之鍋爐,其試驗壓有高出工作壓100%以上者,此種過大壓力,常能發生損壞 Overstrain (尤以螺撐等爲甚).

熱水試驗壓,可與上述者相同.其溫度以 180°F. 爲限.在冷水裝滿後,即在

火箱內用木柴升火.迨應得之壓力達到,卽去火,此法甚善.

上述試驗壓力,祇可延長十分鐘.試驗之前後,(若係新鈑新火箱)須詳察其平整與否.並有無出險之處.試驗完畢,更須內部好爲審察.漏水,螺撐,鉚釘,接縫等之填塞 Coulking, 在壓力之下,決不可工作,必先得壓力縮小而後可.此非特於水壓試驗時宜然,卽後來之汽壓試驗亦無不宜然.填塞Couling, 須用闊圓頭工具 Fulling Tool. 試驗時,壓力表須常爲注視,有時針忽下降,此必爲漏水.若無漏水之現象,則必屬內部之損壞,如螺撐之斷裂,因而頂鈑或牆鈑之凸出等.此壓力忽降落之現象,須於試驗報告上詳言之.

鍋爐裝滿水後(壓表指出零壓),自零至最高試驗壓所注入之水量,須逐步記出.又放低壓力時,所放出之水量亦須逐步記出之.若鍋爐在試驗時,未變形者.此二次之水量,必相等.凡大鍋爐,其相差,最多不可過 100 至 120 立方吋.

汽試驗 Steam Test 時,試驗壓可高出工作壓自 5 磅至 10 磅.此時鍋臉附件如 Fittigs, Cocks, Gage Glass 等,均須裝置,一如行車時之情形.惟最高壓,須至少延長自 4 至 5 小時,其間如有漏水等事,須詳爲記出.試驗後,鍋中必經清洗.

(二十) 塗飾 Painting 鍋爐經試驗清洗後,若不卽應用,須塗飾防銹劑,以免損壞.防銹劑有五種 (1) 石灰 Lime (2) 水泥 Cement. (3) 黑油 (一種混合物內含柏油 Coal Tar 及礦墨 Plumbago 各半.礦墨在柏油沸時和入). (4) 鹽液 Sal Ammoniac (5) 紅鉛 Red Lead. 據 Dr. Unwin 及 Mr. Webb 之意見,防銹劑,祇須於鍋爐熱時,內面以 Sal Ammoniac 洗滌,外面用紅鉛塗飾. (完)

十八年,三月,一日.

THE RECORDS OF LIU HO BRIDGE WITH PNEUMATIC CAISSION FOUNDATIONS

著者劉峻峰 (EVEREST T. F. LIU)

CHAPTER I. LOCATION AND GENERAL FEATURE

The bridge is built to cross the Liu Ho river (柳河), situated at one and three quarter miles from Chang Wu Hsien station (彰武縣車站), 66 miles from Ta Hu Shan (打虎山) and 90 miles from Tung Liao Hsien (通遼縣). It is the largest bridge on Tahushan-Tungliaohsien Branch Line (山通枝路) of the Peiping-Mukden Railway (平奉鐵路). This river appears on the map as Hsin Kai Ho (新開河), starting from Jehol (熱河) passing Changwuhsien, Hsin Ming Fu (新民府), at which the flowing water spreads over so wide an area and the water course is so changeable that the main line of the Peiping-Mukden Railway has to build a series of bridges nearly every year to meet the constant changed conditions. Finally it empties into the gulf of Liao-Tung at Pan Shan (盤山). The water course at the bridge crossing, under consideration, however, is confined to a proper channel at present although there were some changes in the past as told by the old villagers.

The river runs through a country of very fine sand. If you grip a handful of the dry sand, stand in a high position, and let it drop in the quiet air, you will find that no sand would collect on the ground directly underneath, but all fly away. Therefore it gives lot of trouble when brown up by wind in the spring from March to May. The air is so thickly mixed with sand that one can hardly see the objects within a very short distance. On the other hand, when under in water it seems to give a fairly sound foothold. But if you give a little jerk to your legs, you will gradually sink into the sand. Due to this quick-sand action man or beast can hardly get across the river without a special guide whose profession is to find the sound and safe path on the river bed although the water in its lowest stage is only 2 or 3 ft. in depth. Furthermore, the run-off from the surrounding flows to the river always bring in the fine sands when big flood appears in the river during summer time; one can sometimes see at the beginning of flood the running water in a distinctive layer of 5 to 8 ft. thick flowing downward with rapidity much like the crest of a high tide in the sea. The alluvial

thus formed is said to be as high as the flood, as the latter always brings along the fine sand with it. This is the principal cause for the shifting of water channel and also the distinctive feature of a river flood in a desert place.

Chapter II. Boring

Before we take up the design of bridge foundation the river bed strata must be made known to us. Boring is the first thing to do. As the water in the river is only 2 to 7 ft. deep after the raining season and flowing with fairly low speed the boring work is a comparatively simple and easy task. No machinery is needed; only hand boring tools will be enough for the purpose. One gang of 20 men was engaged in October 1926 for the work. The working platform was built up by sleeper stacks (100 pc.) 3″ × 12″ planks (200 ft. run) 2″ × 12″ planks (150 ft. run), and telegraph poles, scaffolding poles (10 pc. each). A tripod formed by 3 pcs. telegraph poles was used for pulling up the casing pipes, sinker bars etc. by ropes running over a pulley on the top. The casing was 4 inch wrought iron pipes in 10 ft. lengths screwed together so as to present a smooth surface on both sides, while the bottom was provided with a steel cutting shoe, having a mouth slightly larger than the pipe. The sinking was accomplished by driving and twisting after the sinker bar and drilling bit have reached a good depth. Auger, or shell with valve, was used to clean the hole and obtain samples from time to time in accordance with the laver of stratum drilled through. The driving of casing pipes was done by using the common wooden hammers. The depth of hole was thus marked and measured by the number of casing pipe lengths sunk or graduations on the sinker bar. The daily progress of boring was from 5 to 10 ft. For the test hole No. 3 it reached a depth of 72 ft. below water line, but after that it was then only a few inches or none at all in a whole day on account of the fine sand flowing into the casing. It was concluded that a hand drill is only good for a depth of about 50 odd feet. The casing pipe was pulled out when the hole completed.

Before the regular boring started, all the pier positions were pegged out and elevations given on the different points. It was so planned that the test holes would be done for all the odd numbers first, omitting the even ones. If the strata were believed to be nearly uniform throughout from the boring profile thus found it would be unnecessary to go over the even numbers, thus saving the expenses for the less number of test holes made. Should strata

prove to be too much reuncriform the even numbers were to be gone through in the second time. Fortunately the boring profile from the odd numbers has furnished us enough knowledge of the river bed strata; and no test hole was made for the even number piers. Throughout the work no other trouble was met with.

We got the results in 50 day's time as roughly shown in the boring profile Drawing plate 1. Strata in the first layer of twenty odd feet fine white quicksand; then a layer of blue fine sand; and some parts with a little percentage of mud. Beneath this, one layer 1 to 5 feet of black hard clay running from piers 1 to 7, while from 7 to 13 one layer of mud with 30 percent sand laying in a greater depath. Boring to a depth of 72 ft. still show fine sand. We discontinued further exploration. Evidently it proves geologically that the original river bed was very low and that the present bed was raised by deposits of fine sand brought down by its tributaries from the desert regions.

Chapter III. General Design of Bridge

WATERWAY.—From the sectional profile of Liu Ho (see Drawing Plate 1), the highest flood level and lowest water line we were brought to understand the condition of river flow during flood. Again, from the highest flood level and the existing feature of the banks, we decided to adopt an over all bridge length of 1250 ft. for the waterway although the ordinary water course covers only a width of 500 ft. In order to utilize the old girders a 12-100 ft. span bridge was taken into design.

The probable highest flood line is 370 ft. and the lowest water 348.75 ft. above the mean sea level, giving a difference of water height 21 ft. approximately. By the common practice the bottom chord of bridge truss should be 5 ft. above the H.F.L. But due to the uncertainty of the flood line and the reduced waterway by the installation of piers a larger clearance must be provided. Hence the bottom chord of the truss was put 8.5 ft. above the H. F. L. With these water openings determined we can proceed to take up the design of structures.

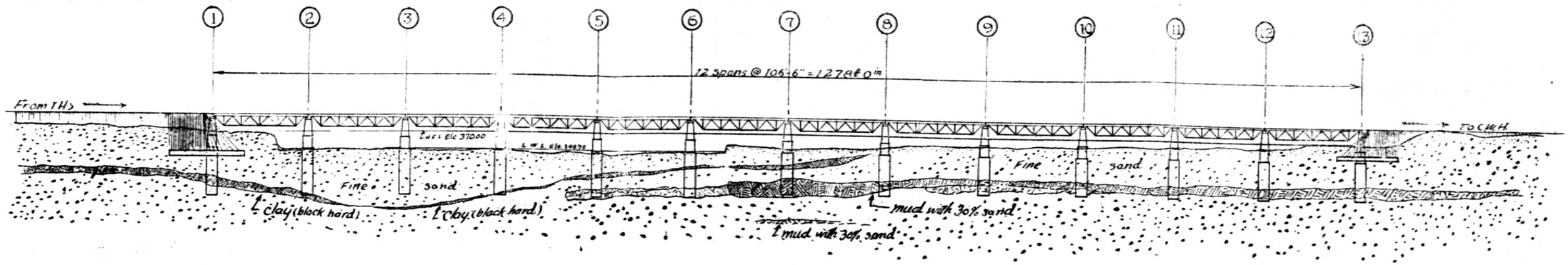
FOUNDATIONS:—We were convinced by the test holes that no hard strata whatever kind could be used to bear foundations within reasonable depth. Now let us discuss the different possible foundations. Pile foundation of shallow depth are unsafe against the heavy scour while piles of longer length than 30′ are exceedingly hard, or impossible to drive into the fine sand

by the drop hammers. If coffer dam is built for the pile-driving the work is exceedingly troublesome and too expensive. Sinking wells by open excavating also does not go a farther depth than 20 ft. in one operation. Sinking well by open dredging process, is out of question due to the uncertainty about the removal of obstacles, if any, and the lack of equipments, although it can reach a depth of 100 ft. and over. After all, the only kind of foundation left to meet our requirement must be the sinking of pneumatic caissons. They are the simplest, most satisfactory means to deal with the quick sand, and therefore the most economical one among the deep aqueous foundations although the cost of installing the plant seems high.

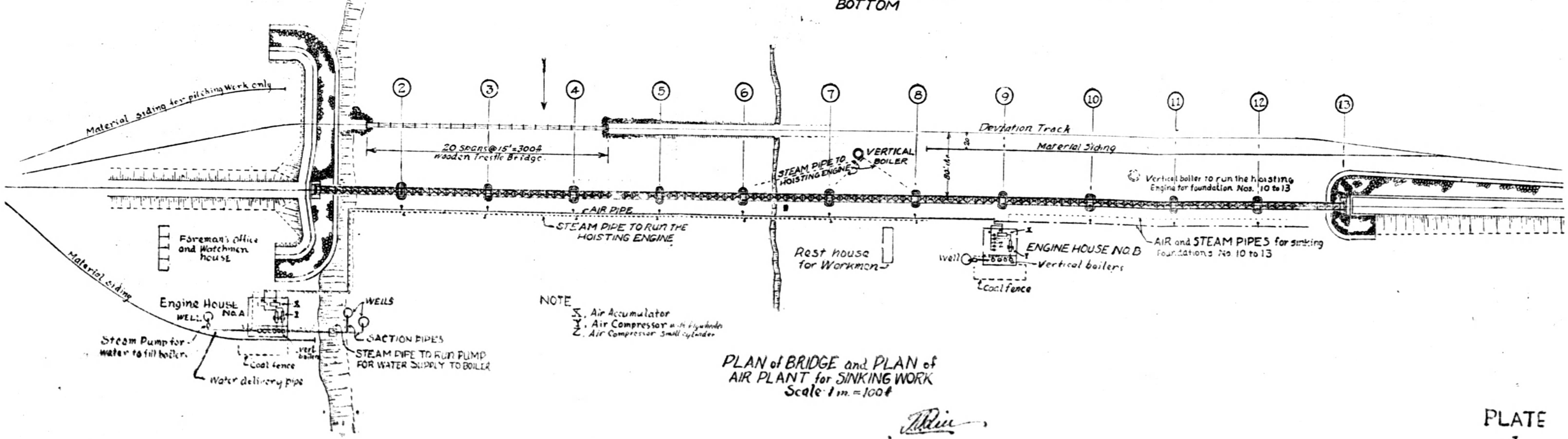
In order to reduce the eddy current to the minimum an elliptical caisson with the major axis 23 ft. minor axis 12 ft.-2 in., and the vertical height 7 ft. 2 inches was selected (see Drawing plate II). The plan of caisson was one ft. wider all around than the plinth for the allowance of adjusting error in position which could only be avoided with considerable care. The working chamber was in the shape of an elliptical frustum, with enough room for ten workmen. As the whole caisson was of comparatively small dimension it did not pay to provide separate shafts for men and supplies. And these were combined for all purposes. The shaft was 3 ft. in inner diameter, placed in the center of the working chamber. The concrete foundation would then be cast directly upon the top of the caisson. Four pieces of I-beams were transversely placed on the top plate of working chamber so as to distribute the masonry dead load evenly and to transmit the weight of shaft pipes to the caisson underneath.

The caissons were made of steel plates and angles by Engineering Works of Peiping Mukden Railway in Shan Hai Kuan (山海關). All the detailed dimensions could be refered to from Drawing Plate II. One caisson was made into 4 quarters, and ready to be assembled by field rivets on delivering at site.

The foundation shell was built of concrete reinforced by 2½" x ½" flat iron as shown in Drawing Plates II, III, and IV, since the tensile strength of concrete was not relied upon for holding up so heavy a mass to one unit piece. To the vertical reinforcement a 4" × ½" flat iron hoop was put around in every 15 ft. so as to keep the former in position and hold up the shell from cracks produced in the periphery. The outer perimeter of the foundation shell was of the same shape but slightly smaller than the caisson so that the skin friction might be slightly reduced while the inner area

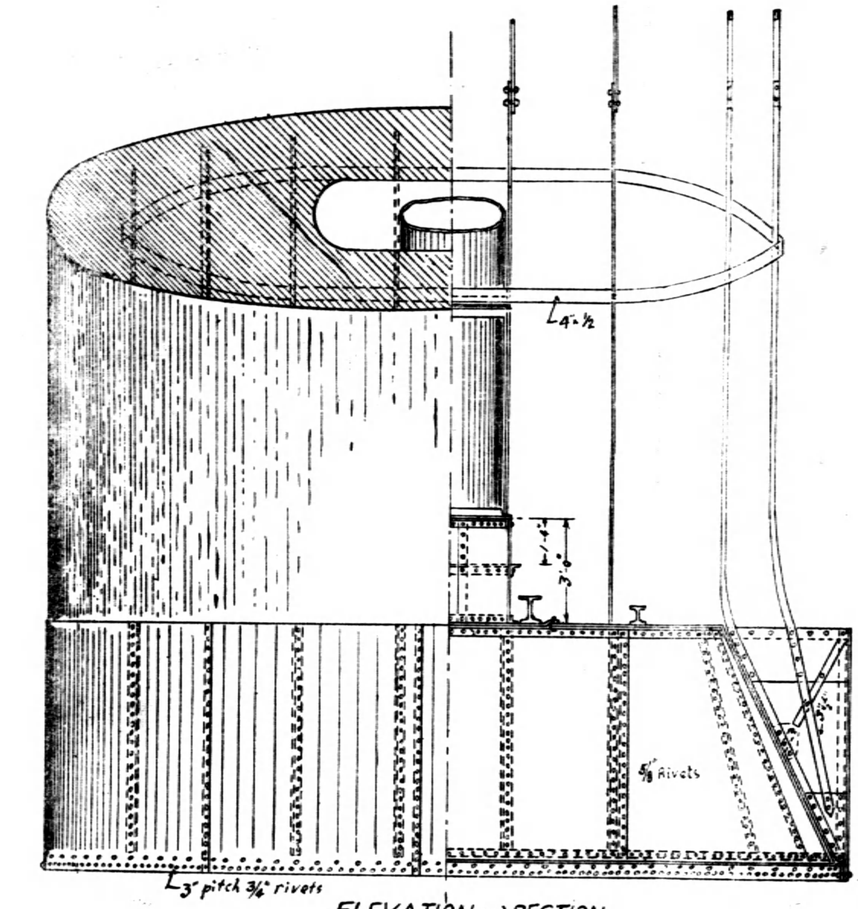


ELEVATION of BRIDGE and BORING PROFILE of RIVER BOTTOM



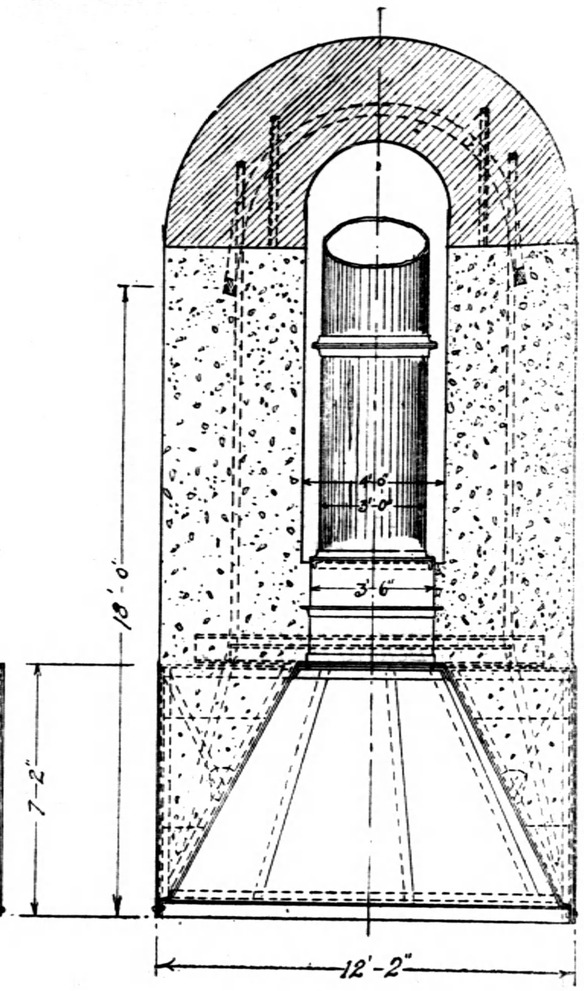
PLAN of BRIDGE and PLAN of AIR PLANT for SINKING WORK
Scale 1 in. = 100 ft

PLATE
I



ELEVATION and SECTION

PLAN



ELEVATION CROSS SECTION

NOTE.- LIST OF MATERIALS SEE SEPARATE PAGE

STEEL CAISSON for 100 ft. DECK SPANS
LIU HO BRIDGE
Scale: 1/4" = 1 ft.

PLATE
II

List of Materials for One 100-Ft. Span Caisson

ARTICLES	QUANTITY	UNIT WEIGHT	REMARKS
¼"×6'6"×7'2" Steel plates	6 pcs.	2795 lbs.	Skin or curb plates
¼"×5'6"×7'2" „ „	4 „	1576 „	„ „ „ „
⅜"×6'6"×8'0" „ „	4 „	2080 „	Air chamber
¼"×6'0"×8'4" „ „	4 „	2000 „	„ „
¼"×5'3"×8'4" „ „	2 „	875 „	„ „
⅜"×4'3"×5'3" „ „	2 „	669 „	Roof plates
⅜"×4'3"×6'5" „ „	1 „	409 „	Collar
⅜"×4'0"×8'0" „ „	4 „	1920 „	Gusset
¼"×3'0"×12'0" „ „	1 „	360 „	Drum
TOTAL		12684 lbs.	
7"×9"×10'0" Steel I beam	2 pcs.	1118 lbs.	Roof beams
5"×6"×8'0" „ „ „	2 „	366 „	„ „
TOTAL		1484 lbs.	
⅜"×3½"×5"×15'0" steel Angles	4 pcs.	609 lbs.	Bottom curb.
⅜"×3½"×3½"×15'0" „ „	4 „	496 „	Bottom air chamber and curb plates.
⅜"×3½"×3½"×22'0" „ „	2 „	364 „	Top air chamber and cover.
⅜"×3"×3"×14'0" „ „	7 „	689 „	Stiffener to skin plates.
⅜"×3"×3"×15'0" „ „	11 „	1160 „	Stiffener to air chamber plates and bracings.
⅜"×3"×3"×12'0" „ „	3 „	253 „	Drum rings.
TOTAL		3571 lbs.	
½"×3"×12'0" steel flat bars	14 pcs.	840 lbs.	Bracings.
½"×2"×15'0" „ „ „	42 „	2100 „	Vertical tie beams.
½"×4"×25'0" „ „ „	4 „	666 „	Horizontal.
½"×4"×8'0" „ „ „	1 „	33 „	Curb angle cover.
LOTAL		3639 lbs.	
¾"dia.×2¼" steel rivets	30 pcs.	14 lbs.	NOTE:—Wt. for one caisson is
¾"dia.×2" „ „	177 „	75 „	22,201 lbs. in gross total, or
¾"dia.×1⅜" „ „	724 „	262 „	9.18 tons net. COST for
¾"dia.×1⅜" „ „	907 „	294 „	one caisson,—Labor for com-
⅝"dia.×1¾" „ „	190 „	40 „	plete reviting (on river bed
⅝"dia.×1⅜" „ „	653 „	138 „	ready for concreting) is
TOTAL	2,681 pcs.	823 lbs.	$1,316.92. Material 22,201 lbs. @ 4.6 cts. is $1,021.25. TOTAL $2,338.17.

enclosed must be large enough for the shaft pipes: 4' wide by 8' long with round ends, the slotted area being provided for facilitating the fixing of the latter. The concrete for the foundation shell was 1:3:6 with 20% to 30% of rubble embedded in although 1:4:8 or 1:5:10 ratios have been commonly used by some other engineers for such work. Our reason for such modification was this—a richer mixture produced a stronger concrete and thereby we might use a sand core to fill the shaft hole instead of concrete, that means to say the greater cost in mixture would be balanced by the saving from sand filling. But the real advantage was the less care taken from the fear of breaking the shell during sinking process.

In determining the depth of foundations we must look for two things: (1) the bearing power of subsoil and (2) the possible depth of scour. As the Liu Ho river is in a fairly graded stage and lies in a flat country, there will be no severe scour to the bed, while the shifting character of quick sand, on the other hand, is not to be over-looked. An assumed depth of 15 ft. as the severest scour will be sufficient. Now let us see the bearing power. In the "Allowable Pressures on Deep Foundations" Mr. Corthell has remarked the safe bearing power for fine sand to be 4.5 tons per sq. ft. when confined to a depth of 23 ft. The upper part of the river bed is of quick sand; and 20 odd ft. below was fine sand. The depth of sinking is thus designed accordingly, and a depth of 40 to 50 ft. below the lowest water line was prefixed in accordance with the existing features of present river bed and the posibility of different degrees of scour during flood. Neverthless it would be unsafe to go by theoritical valves only and would be much better to be guided by the existing bridge foundations in the Railway under similar conditions. Furthermore, an actual investigation was made to pier No. 3 during sinking process and the rough calculations are as follows:—

The total height of founds was 49.42' and about 45' sunk below river bed.

Cross-sectional area of founds=219.66 sq. ft.
Circumferential surface of founds 56.29 sq. ft./ ft. high.

Volume of founds	=10,855.6	cu.	ft.
Volume of plinth	= 2,218.2	,,	,,
Volume of pier	= 2,270.9	,,	,,
Volume of G. S.	= 245.7	,,	,,
Total Volume of concrete	=15,590.4	,,	,,

D. L. (1) Wt. of the above=1091.33 tons.
(2) Wt. track (67 ties @ 222 lb. & 60 lb. N/S rails) =9.55 tons.

L. L. (1) Rolling stock, taking Cooper's E-40 loading=212.0 tons.
(2) I (impact) =P×300/(100+300)=212×0.75=159 tons.

Total load on pier (D. L.+ L.L.) =1471.88 tons.

Now comes finding of the skin friction of the foundation shell with the fine sand. It is difficult to determine unless the experiment is carefully conducted. When at the last operation of sinking the sand in the working chamber was cleared up, all the workmen got up, and the pressure was released gradually, I took the chance to watch the pressure guage and the sinking of founds. As soon as the pressure in the air lock was reduced to about 10 lb./sq. in., the founds began to sink down. Now I just take this as my data to calculate the skin friction. The bottom dirt under cutting edges of caisson is no more, and gives no supporting power. What holds up the big mass of concrete foundation shell in position was air pressure and skin friction. The pressure is now gradually reduced. At the moment of the sinking of the founds, the total weight just overcomes the friction plus the reduced air pressure. If we deduct the wt. supported by air pressure, the net weight must be counted against the friction.

Wt. of concrete 8759x140	=1,226,260	lb.
Wt. of steel caisson	22,231	„
Wt. of reinforcement	2,352	„
Wt. of shaft pipe 46' @ 0.4 c. ft./ft.	9,016	„
Wt. of air lock say	15,000	„
Extra load say	3,000	„
Total Wt.	=1,277,859	lbs.

Area of base of caisson=31,680 sq. ins.

When pressure reduced to about 10 lbs./sq. in. the caisson being to sink down, the pressure on the base of caisson is then 316,800 lbs. The net Wt. held by friction alone is 1,277,859—316,800=961,059 lbs. The height of founds embedded in earth was 44' at that time, giving the total skinal area =56.3×44=2477.2 sq. ft. The max. skin friction is evidently 961,059/2477.2 =388 lbs./sq. ft. As we understand due to the blowing off the skin friction thereof is much reduced. The probable ultimate friction must be greater

than this when the dirt packs around in the settled conditions. It may amount to 420 lbs./sq. ft. But I would like to take arbitrarily 300 lbs./sq. ft. as the safe skin frictional force.

The total load for one whole pier, dead and live is 1471.88 tons. Assume a scour of 15' during flood as before; the net depth embedded in sand is only 30.' Then the effective frictional force must be 283.35 tons. The net pressure directly on the fine sand is 1472—253.4=1218.6 tons. Bearing pressure on the sand is 1218.6/220=5.5 tons/sq. ft. This seems a little too large.

Now let us see the bending moment during such a flood. Assume again the 15' scour around pier,

a velocity of flood 15'/sec., and
a velocity of wind gust 90 miles/hr., or 40.5 lbs/sq. ft.

(1) C (pressure due to current)=27.1 tons, acting at a point 55.15' from cutting edges.

(2) Wa (wind pressure on the exposed area of pier)=2.43 tons, acting at a point 79.295' from cutting edges.

(3) Wb (wind pressure on superstructure)=7.51 tons, acting at a point 83.66' from cutting edges.

(4) Wc (wind pressure on train)=41.46 tons, acting a point 94.16 ft. from cutting edges, or 8' above rail level.

Total Max. bending moment at the point 30' above cutting edge is 3855.025 ft.-tons.

f (fibre stress)=My/I=3855.025×11.5/7265=6.102 tons/sq. ft. or 851 lbs./sq. in. This is quite ample for the tensile stress of concrete. In addition, it was reinforced,—still safer. From the comparative small B.M. we see that no more consideration is needed to understand the safety of the massive pier about the turning around. The only thing left for discussion is the bearing power.

As noted before, fine sand has the Max. safe bearing power 4.5 tons/sq. ft. when it is confined at a depth below 23' of river bed. Now the pressure of this pier is 1 ton/sq. ft. greater than allowable, but the fine sand is confined to a greater depth in the other hand. It may raise a greater

value. It was at last determined by the guide of past practical experience that the said depth would be enough, although a greater depth than this is preferable.

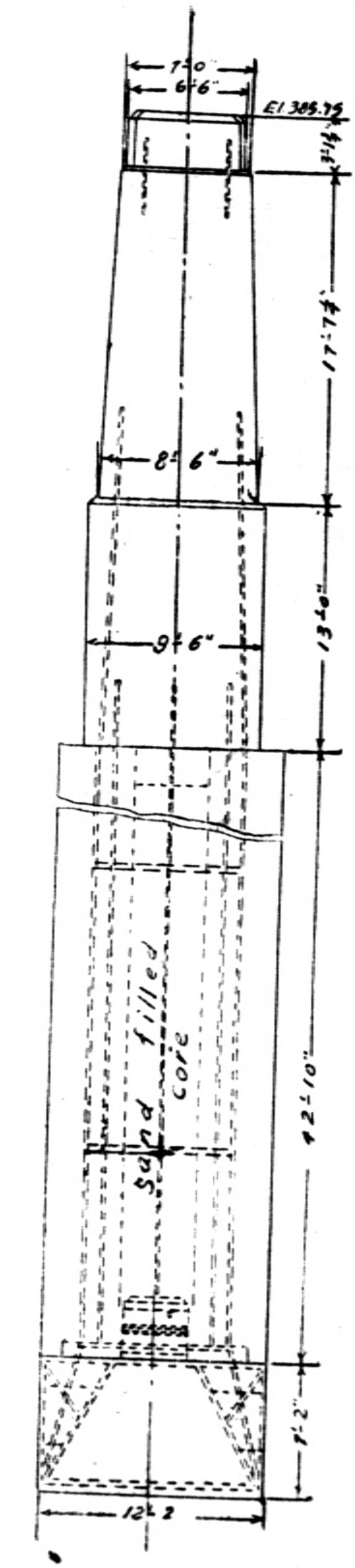
The different depths of the 13 foundations were then determined and recorded as follows:—

DEPTH OF FOUNDATION

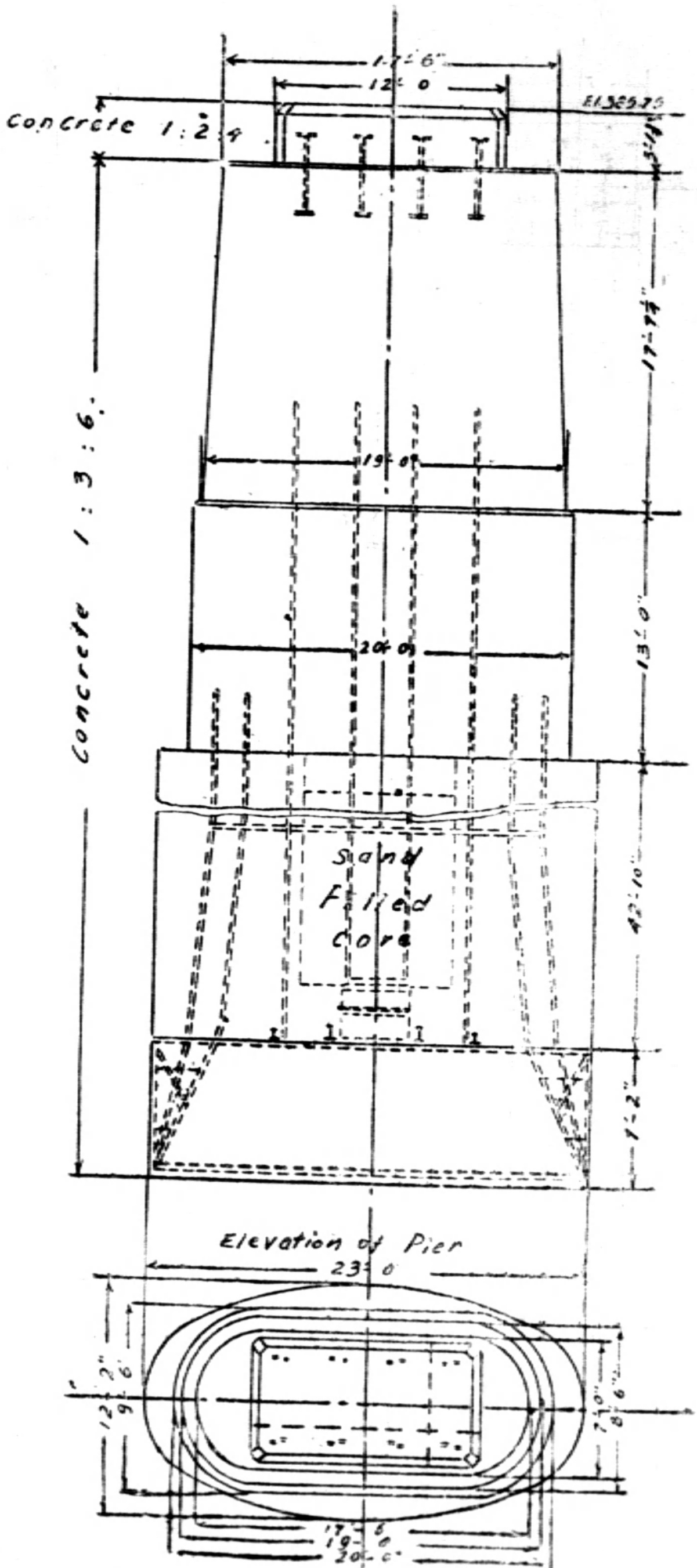
No. of Piers	Depth of con·rete Foundation	Depth of foundations below lowest water line
1	54.42 ft.	53.92 ft.
2	51.42 „	47.83 „
3	49.42 „	44.83 „
4	49.42 „	44.00 „
5	49.42 „	43.83 „
6	49.42 „	43.67 „
7	45.42 „	40.54 „
8	4.542 „	41.08 „
9	41.42 „	38.63 „
10	41.42 „	38.37 „
11	41.42 „	40.40 „
12	41.42 „	41.96 „
13	41.42 „	38.25 „
Total	601.46 ft.	556.41 ft.

SUBSTRUCTURES:—A plinth of 13 ft. was cast on the foundation with parallel straight sides and semicircular starlings. Above this is the pier proper 17 ft. 4½ ins. in height of the same form of plan area as that of plinth but a batter of 1 in 24 is introduced. With a view to breaking the monotony, a rectangular concrete block of 3′2½″×6′6″×12′0″ is put on the top of pier to receive the pedestals of girder, and is therefore called to Girder Seat. All the sharp corners, edges in the above are chamfered off so as to produce a pleasing look. The junctions between the different castings are reinforced by 3″×½″×2′9″ flat irons with hooked ends as plugs to have the monolithic effect.

As for the abutments we have no hesitation to choose the type of buried piers; we have good reasons for their adoptions. Firstly, the design



End Elevation of Pier

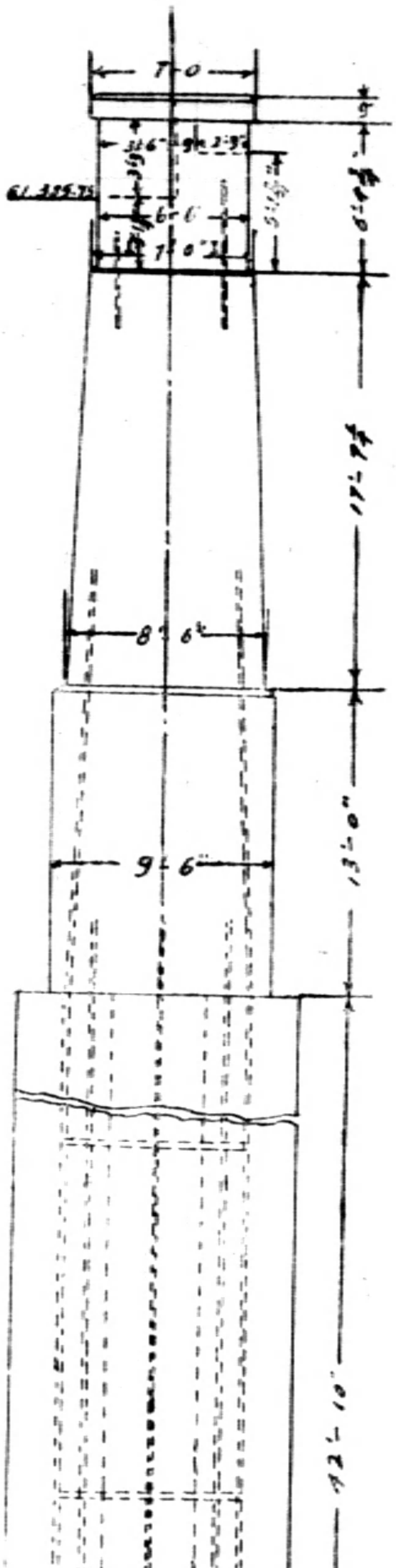


Plan of Pier

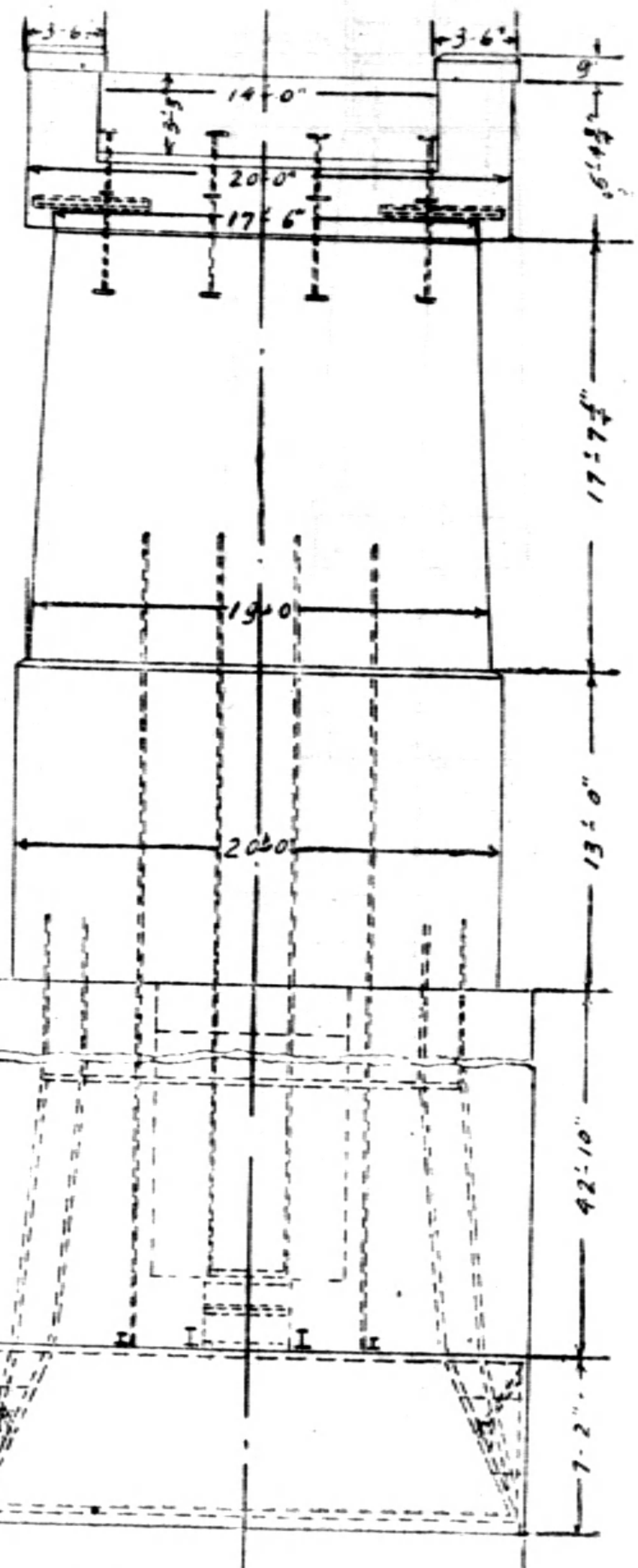
PIER

Scale: 1/8" = 1'

PLATE III



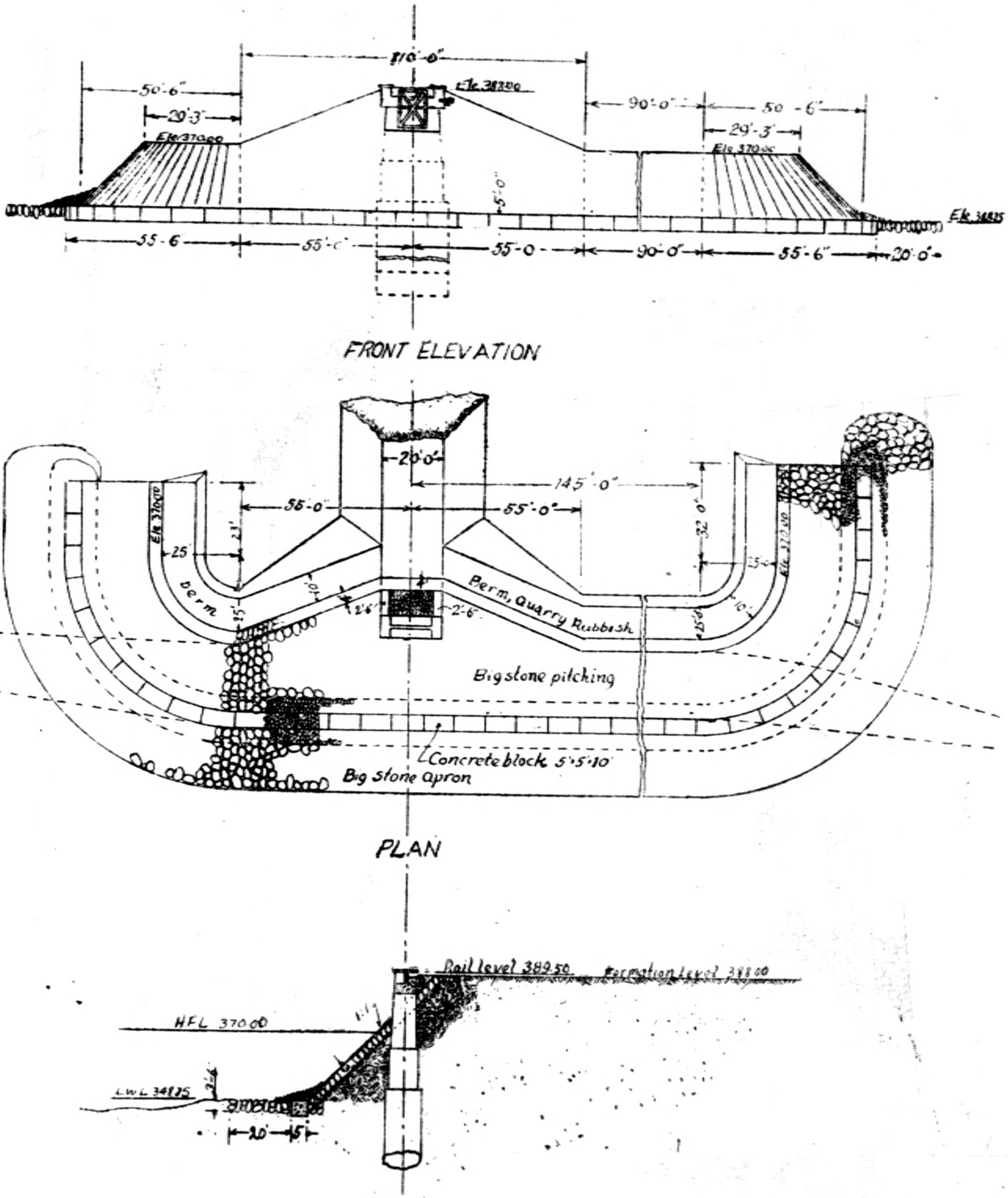
End Elevation of Abutment



Plan of Abutment

ABUTMENT
Scale ⅛"=1'

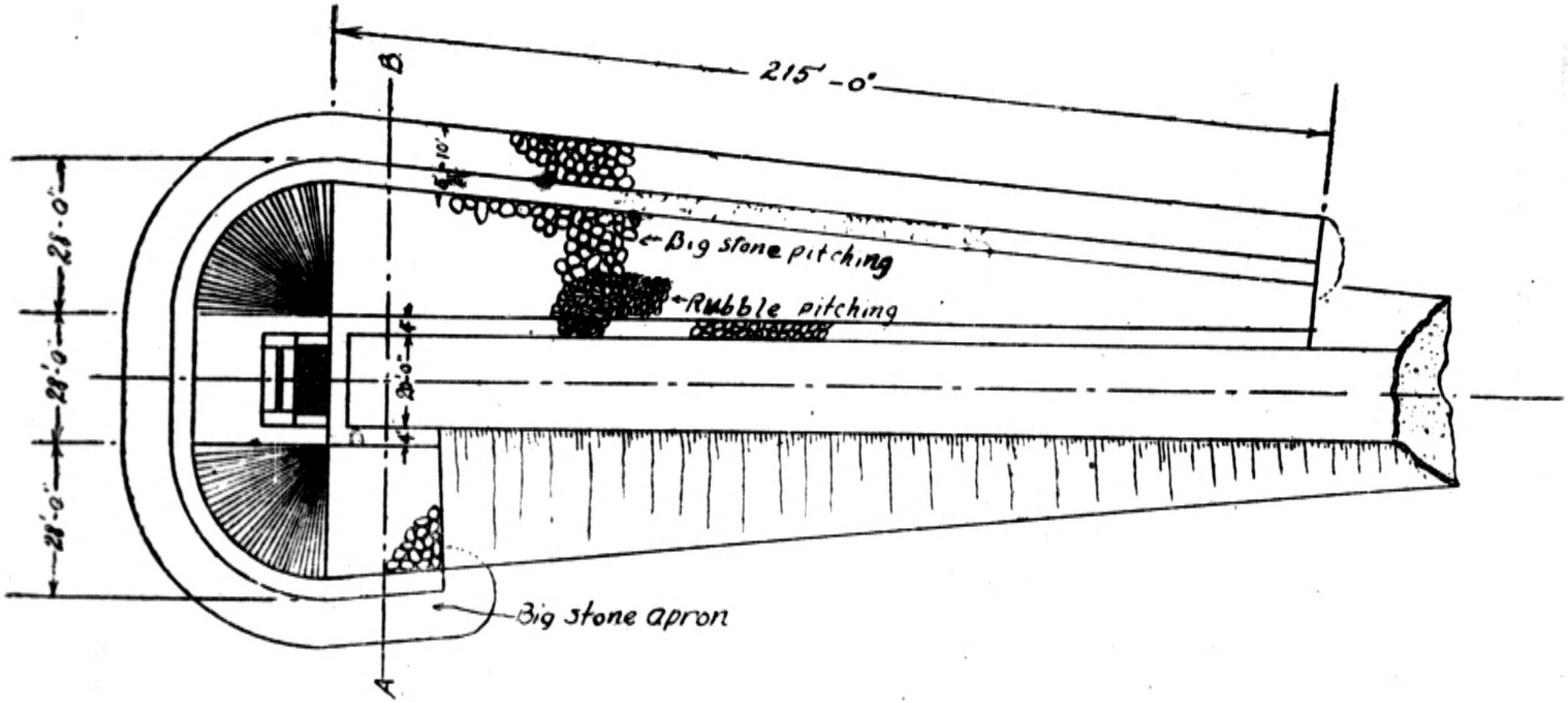
PLATE IV

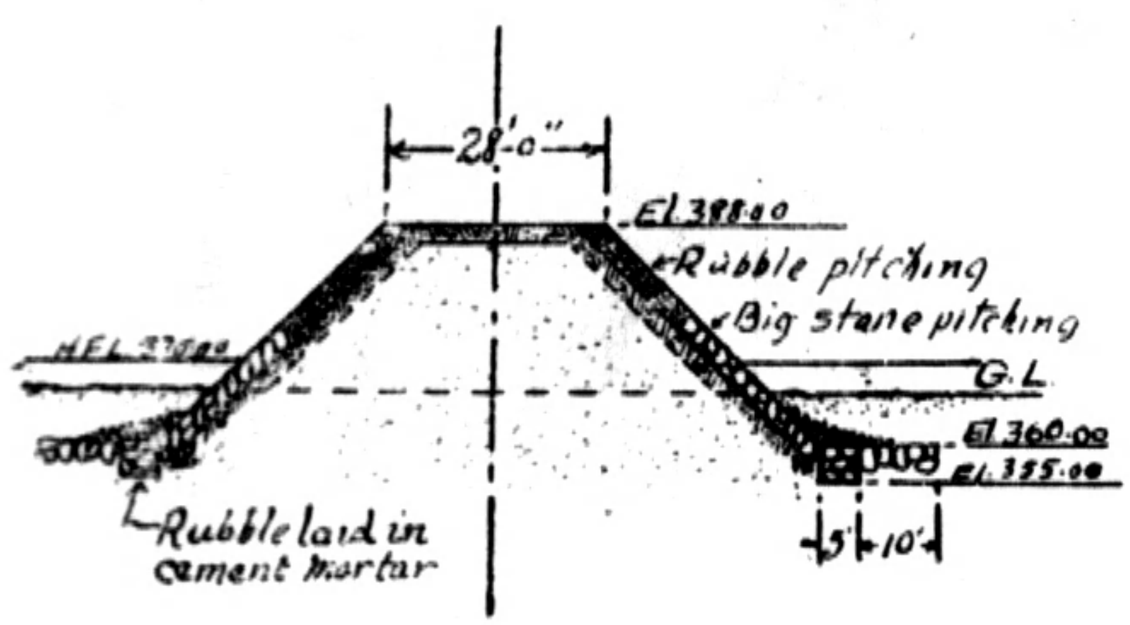


Protection Works. South Abutment

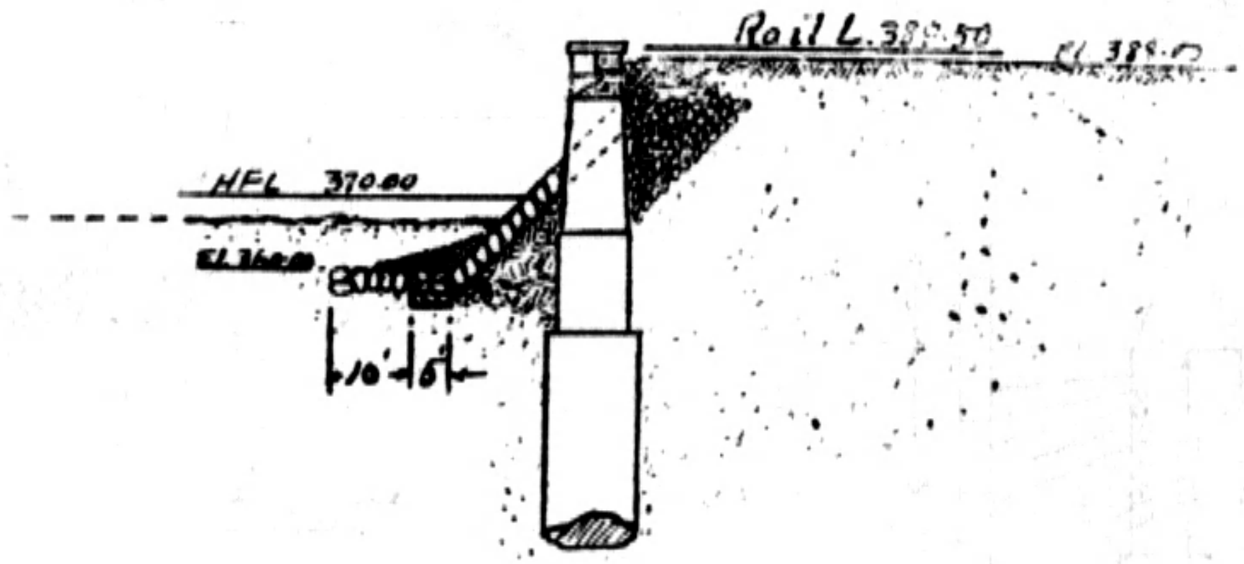
.. Scale. 1 in = 40'

PLATE V





Section AB



Section through ℄ of track

Protection Works North Abutment

Scale 1"=40'

PLATE VI

is more economical than any other types of abutment, as it has no wing walls and does not have to resist the lateral pressure of earth since the embankment spills around it on all sides. It requires no other caissons sunk for the founds than the only one for the pier itself. Secondly, the bridge will not be limited by the abutments but extensible, for some more spans can be added to from either end of bridge whenever the water channel is shifted, which can not be avoided from the geological conditions as discussed in Chapter I. Our design is, however, also involving a little modification from the common practice by omitting the short approach spans at both ends of bridge since present opening of water way is ample enough already. The constructions of the buried piers come out the same as the common piers except that on the top of girder seat a curtain wall is built to retain the earth behind, as shown in drawing Plate IV.

SUPERSTRUCTURE:—The superstructure consists of 12 old E-35 leading girders, shifted from Hsiao Ling Ho bridge in the main line of Peiping-Mukden Railway, where the busy traffic and heavy rolling stocks required the change for heavier girders and 12 spans E-58 loading girders were then specially made for the replacement. The old one is of the Warren truss with vertical deck girder, 106′-6″in over all length, 10′-10″ in height and 8′-4½″ in width. A further description than this, will not be given here as they are the old structures of more than 30 years and the type of structural members was out of date.

PROTECTION WORKS:—The design of protection works is self-explanatory from Drawing Plates V and VI. The south abutment is in the little concaved side of river bank, and of the lowest river bed and therefore is to resist the strongest water current during flood. The pitching work consists all of big stones (2′×2′×2′6″ to 1′9″×1′9″×2′ in sizes, 1000 to 1600 lbs. in Wt.). As for the footings a greater mass is preferable and made in 5′×5′×10′ concrete blocks. In front of the footing a protective apron of 3′6″×20′ is laid around. And rip-raps dumed on the top of the latter near the footing and the footing blocks themselves so as to provide enough quantity of rubbles to refill the washout underneath when scour happens during flood. Beneath the apron in the up-stream side willow "babies" were used offord a better means for protection against scour. We have planned, however, to build spur dykes in the up-stream side and rip-raps with willow matress for bank protection in some day if the scheme of present pitching works show any sign of failure.

The ground surface in the nor.h abutment is nearly as high as the highest flood level. Hence there must not be any severe scour there and the protection is accordingly designed with light work. The footing is built of common rubbles laid in cement mortar and grouted, which requires no less cement than the concrete, but with a saving resulting from doing away with forms and less cost in labour. Should the scour be sc heavy that the present protection works would fail, the bridge would have to require some additional construction as water channel might have been shifted since such high ground would have had been washed out. Therefore, the light work is thought alright. The big stone pitching is used only to a height 5 ft. above the ground level; the remainder being pitched with common rubbles.

Chapter IV. Deviation of Water and Track

The water course spreads to a width of 500 ft. and has an average depth of only 1 ft. or less in the dry season. For facilitating the work, it is preferable to have narrow channel notwithstanding the greater depth resulting therefrom. Besides, for the purpose of better communication deviation track was laid across the river first at the end of December 1926 by putting a temporary bridge. The water was thus deviated by using sand embankments from both sides, covered with quarry rubbles and rubbish.

The temporary bridge was first built of 10-15′ spans of wooden trestles with 20′ pile foundations in such a great hurry for track laying that only enough opening was left for the present water, a great part of which was frozen into solid ice at that time. In the next spring, March 17th to 25th 1927, the big pieces of flowing ice with full damaging force, clogged the bridge openings, and did us not a little trouble. Fortunately, the trouble with ice was foreseen a few days ahead by fixing up a series of wooden frames of 2-40′×12″×12″ oregon logs on the water surface in the up stream side of bridge opening, forming an angular nose of about 65°. The nose rested on a temporary pile driven directly underneath and the two other ends of the logs were fastened to the piles of woodern trestle. The immense force of the flowing ice was thus absorbed when striking the logs, and then the ice was broken into small piece and led through the bridge openings by workmen in day and at night. For one week's time all the ice melted and the trouble was over.

When the flood season came, the track was broken and the temporary bridge taken off in 20th of June 1927, the piles being left in position.

After raining season the temporary bridge opening was then enlarged for another 10-15′ spans of wooden trestle to pass the then increased volume of water. The old piles were adjusted, the new piles driven, and the decking replaced. The track resumed its communications on the 3rd of August. In the whole season we had one and only one big flood about 15′ happened in the river and thus only a few pieces of the old piles left in were washed out off the vertical position, which were adjusted by helper piles and bracings afterwards.

The deviation track was 4500 ft. in length with a grade of 1 in 60 at both connecting ends and level in the middle, laying at 80 ft. up stream side of center line of bridge. The fine sand in the vicinity of river brings difficult and given troublesome question in the maintenance work for the deviation track. On a windy day, especially in the spring, the track may be buried up in 5 minutes if no workmen kept working out the sand continuously. Twenty trackmen at least were kept to clear out the sand daily. As many as hundred men sometimes were required to line up along the track for the purpose, shoveling with great rapidity. Even so the rate shoveling out for times failed to beat off two incoming sand and trains had to stop at near stations to wait. The cost for maintenance thus run high as shown in Chapter IX.

In connection with the deviation track three sidings (see Drawing Plate I) were laid for loading and unloading materials, tools, and air plant machinery. They were so placed as to suit the different purposes in their respective economical arrangement. The one in the upstream side at south bank was good only for bringing the heavy stones to a nearer distance to working site, while the other in south and one in north were necessary for all the works throughout.

Chapter V. Foundation Sinking Works

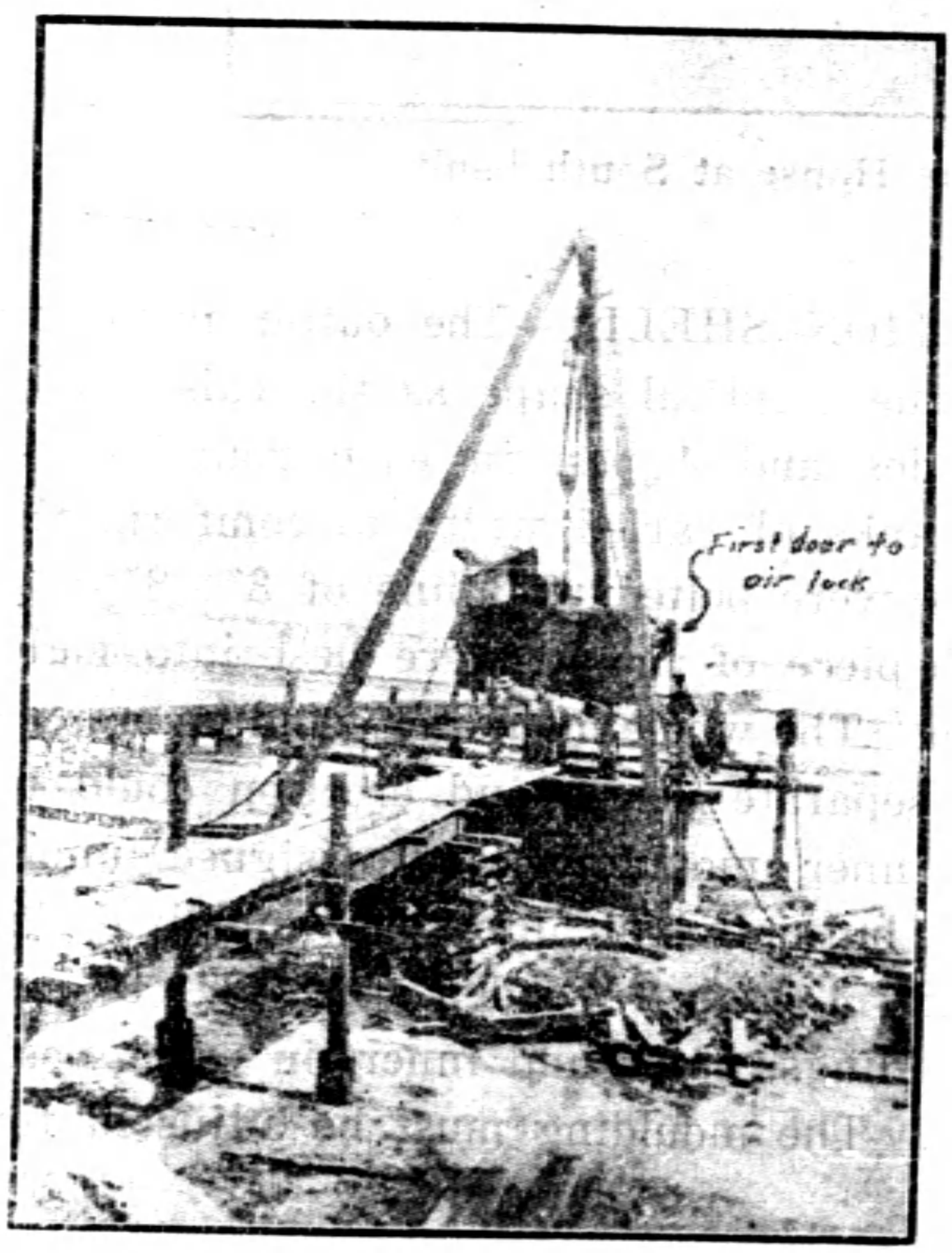
AIR PLANT:—The bridge work was started at the end of April 1927. One air compressor requires two boilers (P.M.R. standard construction vertical boilers) to supply steam for its running. If two sets of compressors in use four boilers must be fired accordingly. Two extra ones, however, must be provided for reserve in case of washout or other accident. Therefore in total we had 2 air compressors a air accumulators and 6 vertical boilers in the house. One 4′-0″ well of 25′ depth were drilled and brick lined in the south

of boiler house in the 1st time and one steam pump used for the supplying water to boilers. The water was then found not sufficient. Two small open cut wells were excavated in river and another steam pump added to supply water to the boilers. 4" air pipes and 1½" steam pipes were afterwards led from the engine house to the working spot.

Caissons No. 1 and 2 commenced to sink in the beginning of June 1927 and sunk home at the end of month. Then the flood was to come and the sinking work suspended in July and August. During this flood season the concrete work in piers No. 1 and 2 was completed, and another temporary engine house was built up in the North bank, in which one air compressor (big type with 2 flywheels), 5 small cylinder type air compressors, 2 air accumulators and 4 vertical boilers were installed. Another 4' brick lined well was drilled for water supply. Air pipes and steam pipes were fixed out. For such arrangement 3 caissons could be sunk simultaneously. After flood season the sinking work was resumed on 1st of September.

When air pipes are too long, the effective pressure would be much reduced on account of pipe frictions, and the danger of pipe breakage also increases. So it is not advisable to use one power house only in one bank to supply pressure to the working spot at the other. Hence we decided to erect two power houses: one to supply power only to 500' distances. (See Drawing Plate 1) For the 4 piers No. 4-7, the pressure was supplied from both sides. One line of 4" pipes was connected to the air accumulators from both ends with stop valves provided near each pier so that the air pressure might be let to the caissons in sinking desired by rubber hose. The air pipe was supported by sleepers driven to river bed under each joint. The steam pipe was used to supply steam pressure to the hoisting engine. When too long, it was also not advisable due to the reduced efficiency by transmission. So one extra vertical boiled was shifted around and put up to the place whereby the work was facilitated. hen the weather was getting cold, it would be better to have the air warmed. The steam pipe was therefore put just under the air pipe and bounded with straw ropes, thus securing several advantages: (1) less danger in breaking the air pipe due to the contracting force outside and bursting pressure inside; and (2) the better temperature for workmen in the working chamber. In warm weather on the other hand, the reverse is true; air lock should be cooled by blanket soaked in water for its protecting covering.

AIR LOCK & HOISTING ENGINE:—The air lock is of 3 section type; one for entrance to workmen and tools, the middle one directly on top of shaft for the ingress and egress of men and materials, the third one only for the out put of dirt excavated. The workmen get down or climb up the shaft to or from the working chamber by the means of steel ladders riveted to the walls of the shaft pipes, while the out put of dirt excavated under the working chamber was put into iron bucket which was pulled by the hoisting engine. The hoisting engine was run by steam from the vertical boilers. The engine was mounted on the top of the air lock.

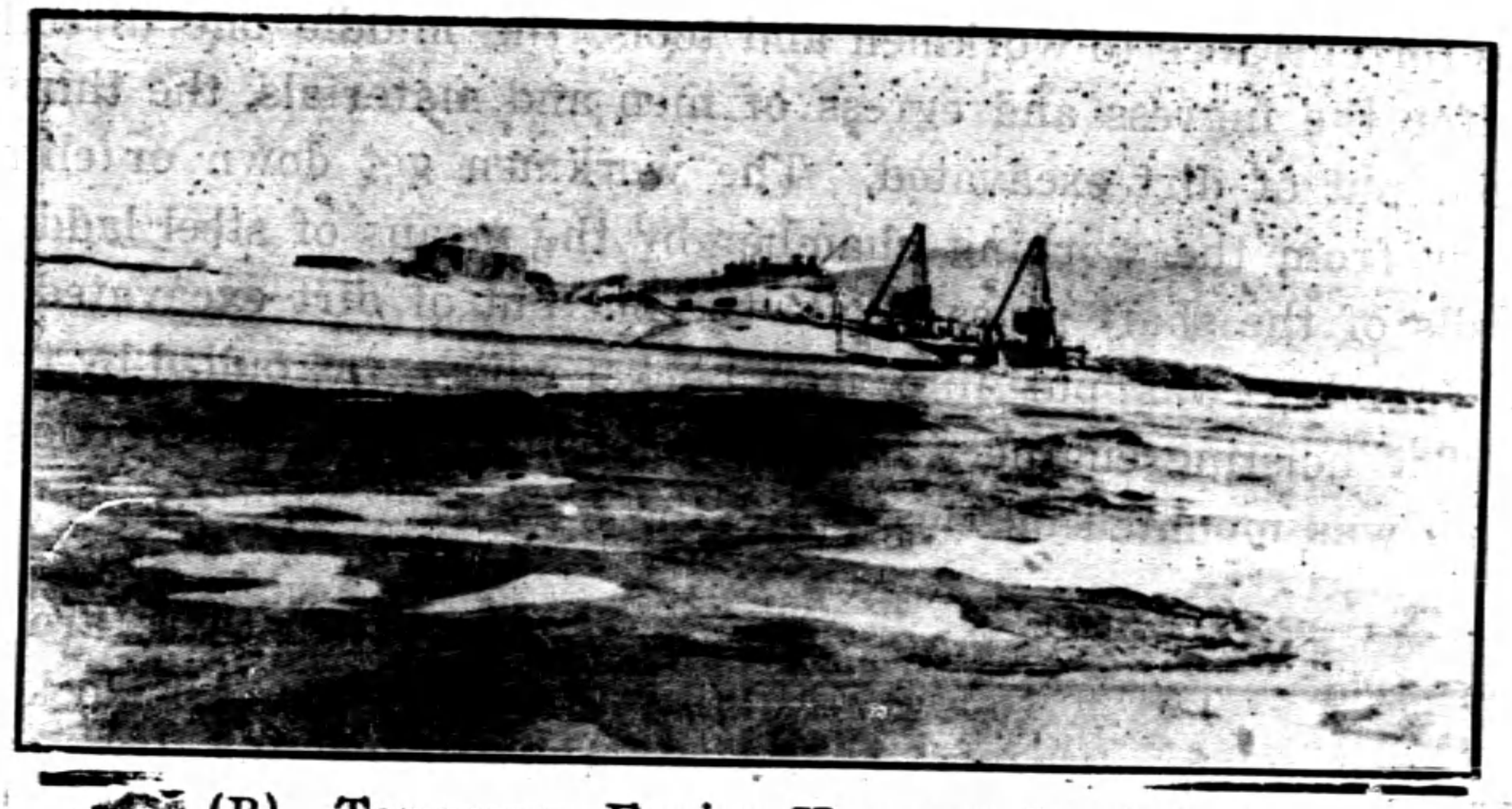


(A) Air Lock and the Tripod

In practice there are two ways to place the air lock;—One is directly on the top of working chamber, and the other on top of shaft pipes. Since our foundation shell was too small for the former method, we had to adopt the latter by placing the air lock on the top of shaft although it involved the difficult condition for workmen to climb up a greater height under heavy pressure.

Standing above the sining shaft one tripod was made of 3 pieces of 12″×12″×50′ oregon logs the top joint of which one 1½″ round iron pin was bolted through. One 1″ iron hoop was put on the pin to receive a 2½″ triple or double pulley block for manila ropes to pull the air lock when necessary.

The only available illuminating power in the working chamber and air lock we could use here was canddles, which gave a much brighter light under air pressure inside than it did outside due to the larger supply of oxigen in the former. The canddles, however, must be of the best quality, or the smoke produced is harmful to the workmen.



(B) Temporary Engine House at South bank

MOULDING FOR FOUNDATION SHELL:—The outter moulding was built of 2" oregon planks in the same elliptical shape as the caissons in 10 pcs;—two large pcs. in both long sides and 4 pcs. in each round ends. They were 8'-3" high. The wooden planks of varied width to comform the cuvature with both faces planed smooth, were bolted to 3 line of 3"×3"×½" steel angles the ends of which in each piece of mould were best into right angles with bolt holes provided thereon The whole moulding could be erected easily only by bolting together the 10 separate pieces and erection could be done within two or three hours. The inner moulding was designed under the same scheme as for the outter one, but only built into 2 pcs. equally divided at the semicircular ends and of only 4' high. Wooden struts 3"×3" and 4"×4" were necessary to keep the mouldings, outer and inner, in exact position, and removed when concreted up. The moulding must be adjusted for watertightness for use each time.

GENERAL PROCEDURE IN SINKING WORK:—The centre line of bridge must first be pegged out by transit with great care. At each end of embankment at both sides of river one concrete peg must be cast as the permanent transit station. One temporary transit hut built thereon was quite useful. The distance between piers marked out with steel tapes in exact measurements. Then for each pier two permanent concrete reference pegs were set with right angles to the center line at convenient distances from both

sides. Several permanent bench mark; for leveling were also to be made and checked in convenient places to suit our use. The water in Liu Ho was pretty shallow throughout. It was deemed wise to fill up the river bed by sand to form an island instead of shipping the caisson on river bed directly, as it would be hard in adjusting the right position by the latter method. Then the different parts of the steel caisson were transported to position on island. They were erected and riveted. Field riveting work was done by contractor's force with 2 sets of forges. 8 men could finish the riveting in two days. After the caisson was adjusted in position open excavation began. As soon as the water in caisson was too deep for work, the caisson was concreted to a height of 2′—3″ above the top of working chamber with 1:3:6: mi-ture. Meanwhile the tripod for hunging air lock was erected.

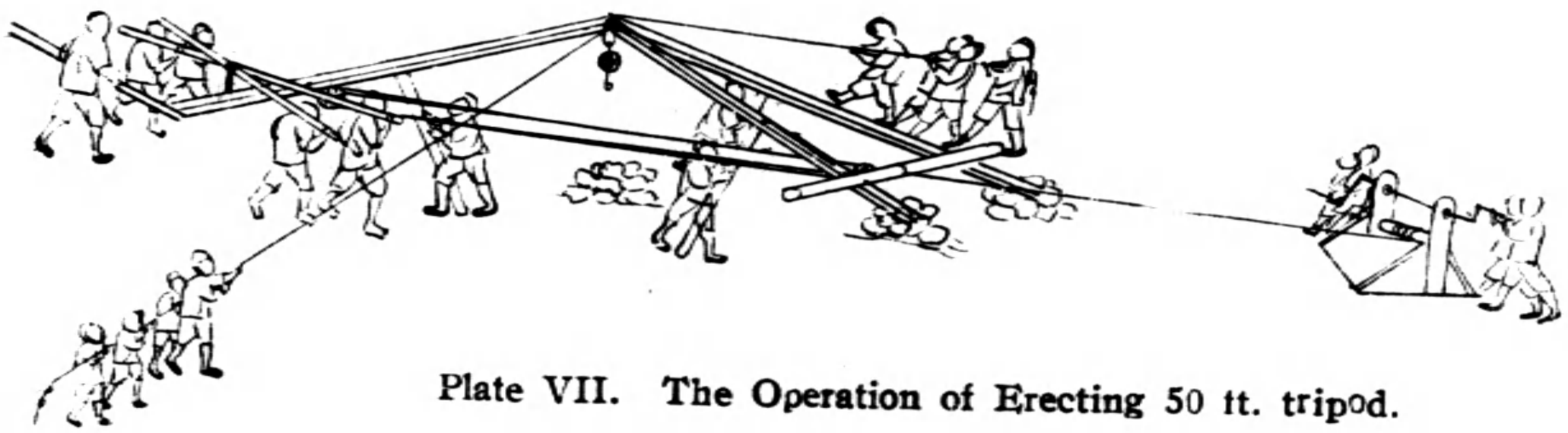
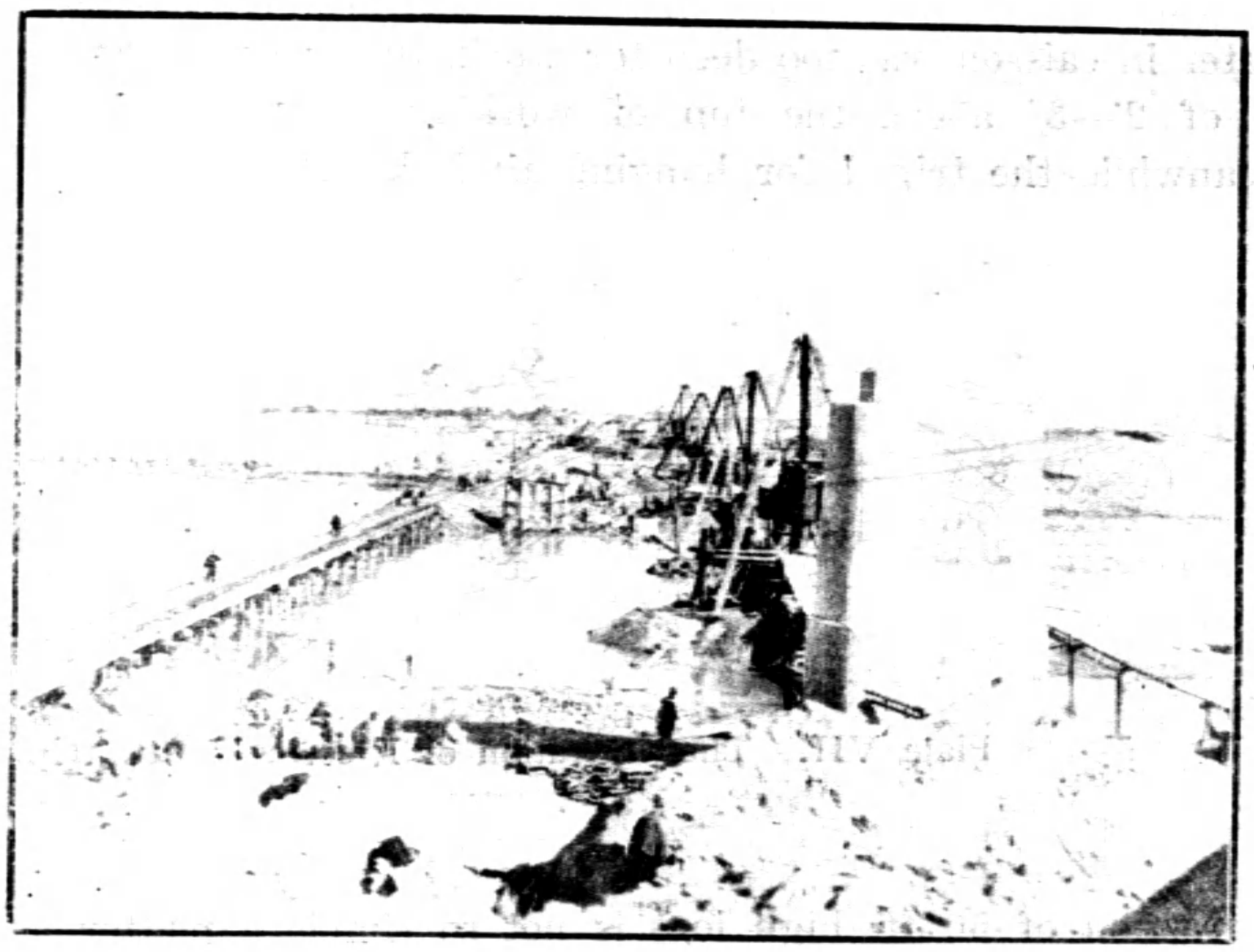


Plate VII. The Operation of Erecting 50 ft. tripod.

The erection of 50 ft. high logs is not so simple a matter as it looks. After several trials the following method was found the most convenient and than adopted throughout the job (See Drawing Plate VII). Place two feet of the legs in their proper position. One 20′×12″ pile was fastened at both ends to the two feet with ropes as a strut or tie rod. Now a 1″ double or triple pulley block was tied to the middle of the 20′ pile while another block to the foot of the third log. Manila rope was passed around the blocks. Human force or hand which was used to pull the end of rope, thus moving the third foot gradually to position and the tripod raised. To aid this move-ment 4 men were required to lift the third foot and one man to move it by means of a pole in lever action so as to reduce the friction with ground sur-face; also one man under each of the three legs moved along with one pc. of sleeper as a jack in order to lighten the weight in question. With precaution

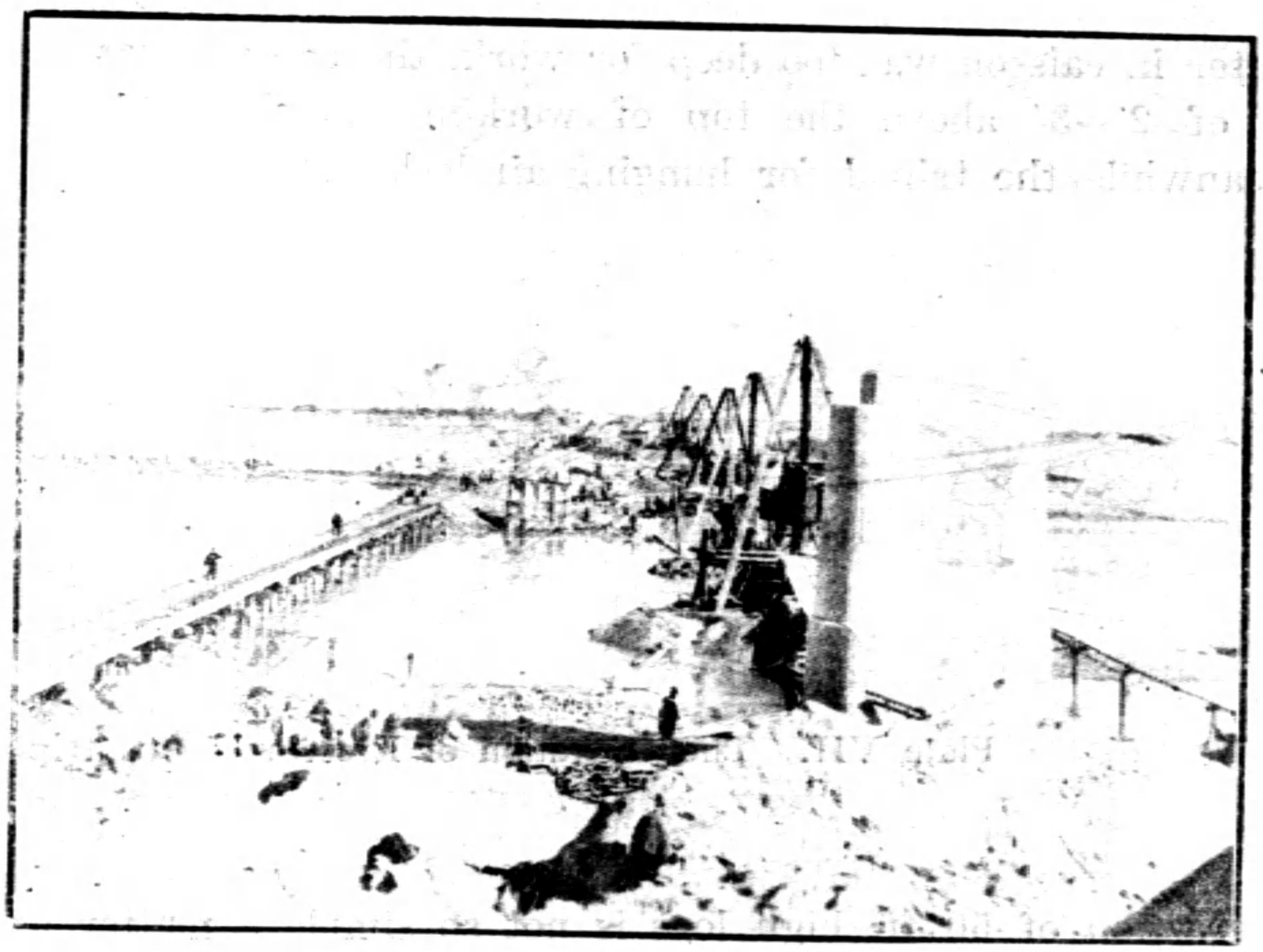
to prevent the tripod from inclining towards either side, two lines of rope were tied to the top of tripod to maintain its position, 5 or 6 at each of the two ends of ropes. The footing of the tripod, however, must be a sound one; built up of rubbles. Once, a footing at pier No. 4 was a little soft. The tripod was then turned down with an air lock no sooner than a strong wind current blown against. Fortunately, no great damage done other than the bending one pcs. of air pipe by the blow of falling weight.



(C) Sinking Work, taken from up stream side

After the concrete setting well and mouldings stripped off (3 to 7 days in accordance with temperature) the shaft pipe and air lock may be fixed up and pneumatical sinking started right away. If water line is too near the top of working chamber another length (8′ in our case) of concrete must be added on before starting the sinking. For this size of working chamber a sinking gang of 15 men is quite enough. Three shifts of the working force in sinking were changed around in day and night. After the air and shaft pipe fixed in right conditions and tesed in perfect air tight, 10 workmen got into the air lock with their tools and candles. Eight of the ten got into the working chamber, six to do the excavation and two in charge to fill the

to prevent the tripod from inclining towards either side, two lines of rope were tied to the top of tripod to maintain its position, 5 or 6 at each of the two ends of ropes. The footing of the tripod, however, must be a sound one; built up of rubbles. Once, a footing at pier No. 4 was a little soft. The tripod was then turned down with an air lock no sooner than a strong wind current blown against. Fortunately, no great damage done other than the bending one pcs. of air pipe by the blow of falling weight.



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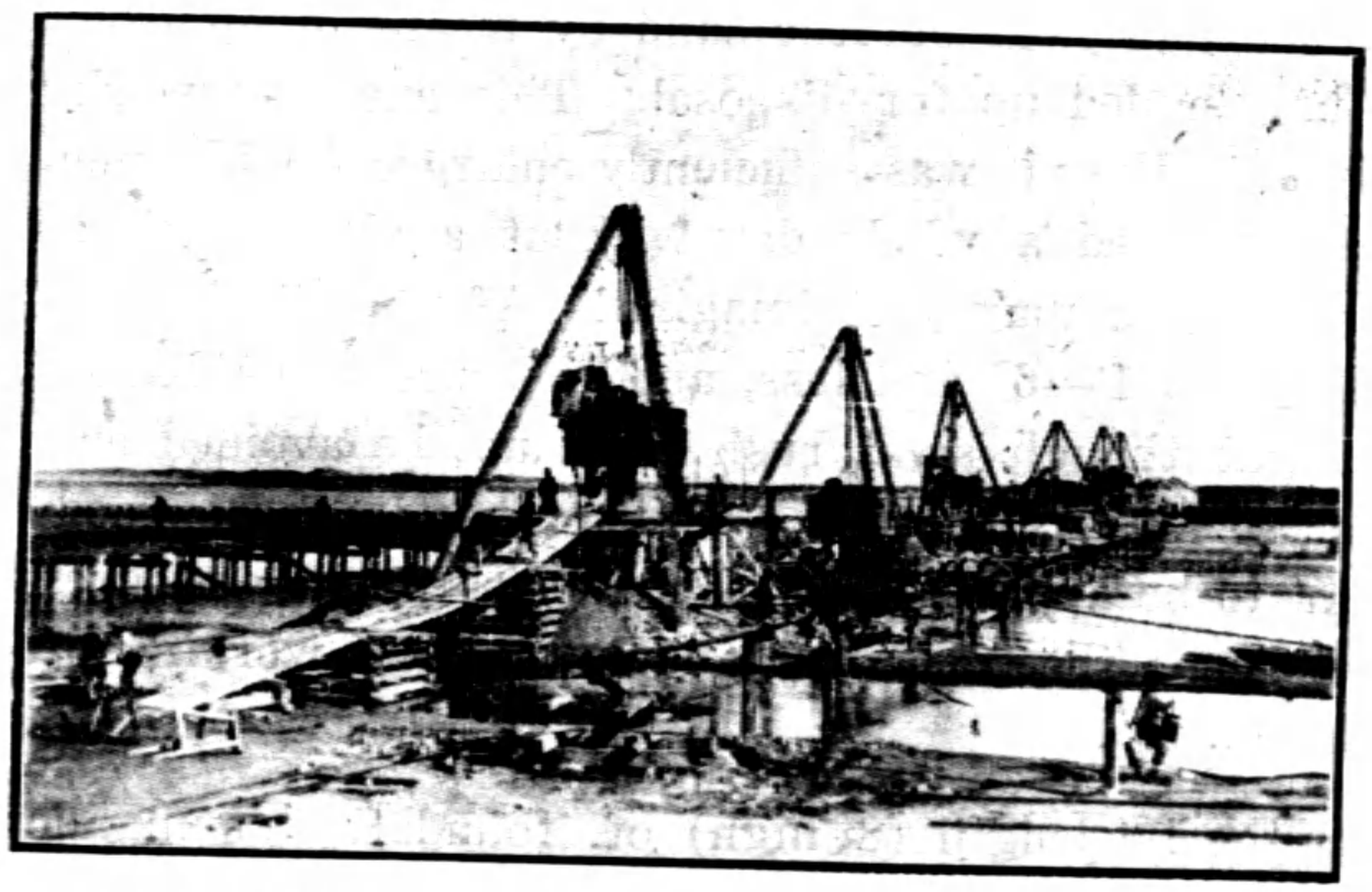
dirt into iron bucket. Two men remained in the air lock; one cared for the brake of the hoisting engine, pulling the bucket aside when full, sending the same down shaft when empty; the other engaged in pouring out the dirt from bucket to the out put hole. On top of the outside air lock one fitter operated the hoisting engine, opening or closing the steam valve in accordance with the signal sounds. When the dirt was poured into the hole from bucket, the inner cover of out put hole was closed and the other cover then opend from outside. Dirt dropped off and was cleaned away by 4 men standing under the air lock outside. The bucket was sent down and refilled and the whole operation repeated again and again until the room in working chamber was large enough for sinking down.



(D) Sinking Work, taken from down stream side

The excavation of dirt under chamber was started in the centre and gradually cut outward to the cutting edges. One strip of 1′-6″ to 2′ wide of dirt (for this kind of soil—fine sand) must be left along the cutting edges during the excavation. When deep enough for one sinking, concentrate all the force to clear away rapidly the dirt thus left along and dump it to the centre of chamber without hauling it out. The workmen would then all get up with tools to the air lock. Then a special sound was made to notify the engine man to cut off the air pressure from outside. As soon as air supply stopped the caisson sunk down gradually. And by this process the whole operation

was repeatedly gone through until the top concrete shell was only at convenient height above water line for concreting work.

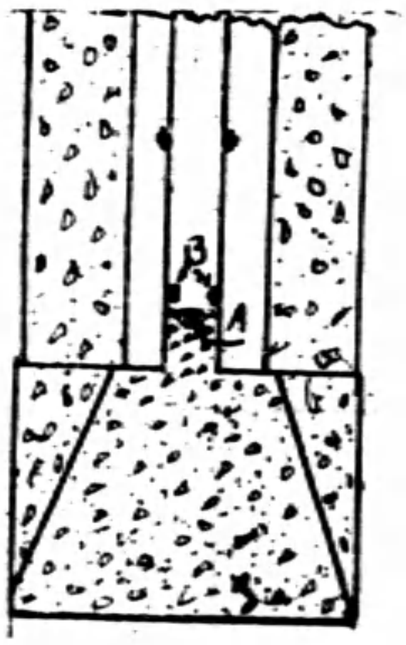
Well, the process for sinking is quite plain and easy as seen from the above discription. Yet, in practice skill and experience are of supreme importance. In sinking foundations No. 1 and 2 the contractor was too anxious to run fast by thinking that the greater depth sunk one time must be more economical than the many a time of smaller depth. But he never thought the reverse was true. He tried to sink the founds 2 to 3 ft. at a time by suddenly releasing pressure. For every trial, however, contrary to his expectation, the fine sand ran in with water to the chamber; sometimes it was so serious that the chamber was all filled up even to 1 or 2 ft. in the shaft. In this case, when pressure applied again only one man could be admitted to get down the shaft to clear out the sand by means of an iron ladle and put into a hemp bag hauled up for disposal. This one man work must be kept up continually until the pit was sufficiently enlarged for two men to work; but sometimes they worked a whole day without a single inch advance. How slow the progress you may just imagine! Afterwards the sinking for one time was limitted to 1'—6" and less, and pressure to be reduced by degrees. It worked alright though sand rush could not be avoided entirely; but not in any way as serious as before. "Blow off" is indeed a good means to aid sinking but not to be applied here! Furthermore, the progress of sinking depends largely upon the consistent and harmonical working of the different parts of workmen, too.

After the 1st length (8' high) of foundation sunk down, the air supply was cut off, the air lock lifted and hung up to the tripod. Some lengths of shaft pipes might be removed, too, in case of inconvenience. The mouldings were then erected again and concreted for another length of 8 ft. In the erection of moulding skillful workmanship and care are required to make good smooth surfaces at the junctions, otherwise a great resistance to the sinking might be produced. The slight error in alignment of foundation might be corrected by the concreting in the second time.

The foundation shell could be made entirely water-tight only with great care. The junctions between different castings are usually the source of leakage. When water gets into the place between foundation shell and shaft pipe, you are not to worry about. It does no trouble, just let it stand there. It is said that the workman suffers less in a little airy chamber than in the

one entirely air tight like sticky clay stratum. As the Liu Ho river bed is nearly all of fine sand, the air under pressure always tried to find its way escaping. When the foundation was sunk about 40 ft. below water one can see the air bubbling all around the working site within a circle of about 100 ft. radius.

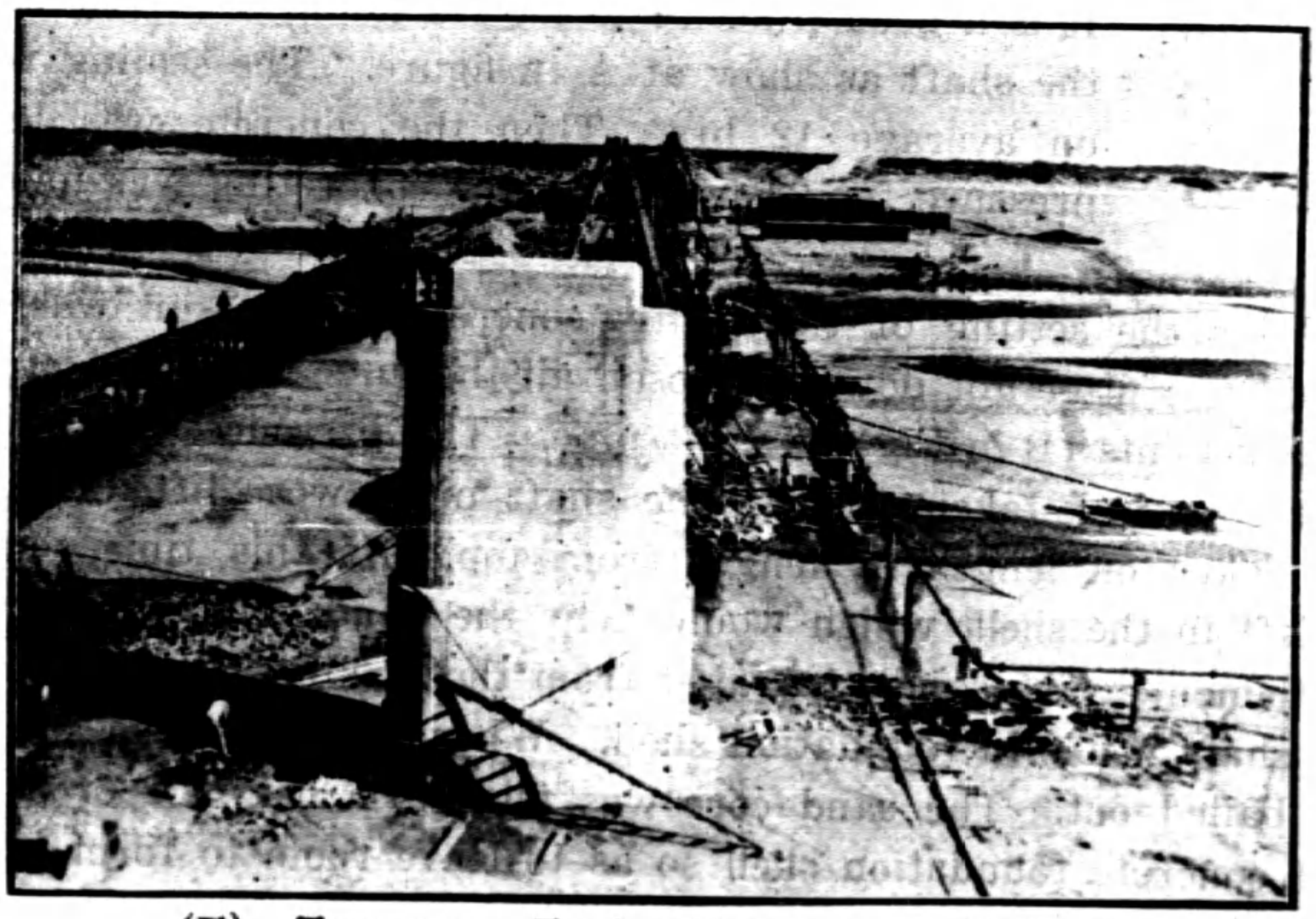
SEALING UP THE WORKING CHAMBER:—As soon as the foundation shell was sunk home according to Engineer's instructions the last gang of workmen must get the soil under chamber leveled out, clear the cutting edges of caisson; and all the exposed inner surface of chamber washed with water so as to clean off all the dirt from sticking there to. The hoisting engine is stopped for working; a special valve at top of air lock is put on, and wet concrete mixture poured in cu. ft. by cu. ft. Two or three men inside the chamber ram the concrete compactly, especially under the cutting edges. When concrete filled to only 2 or 1 ft. near the top plate of chamber it is pretty hard to get the concrete sound by ramming. All the voids thus left in, however, could be well filled by pouring into the chamber a large quantity of cement grout; fluid can easily find its way under heavy pressure. The concrete then continued to be poured in until all the chamber filled and up to 2′—9″ to the 3-ft. shaft pipe above the top plate, leaving enough room to remove the bolts thereon. It is a good practice to have a lot of cement grout left in the shaft as show at A in figure. The sealing work took on average 12 hrs. Then the concrete was left under pressure for 24 hrs. after the concreting was finished.



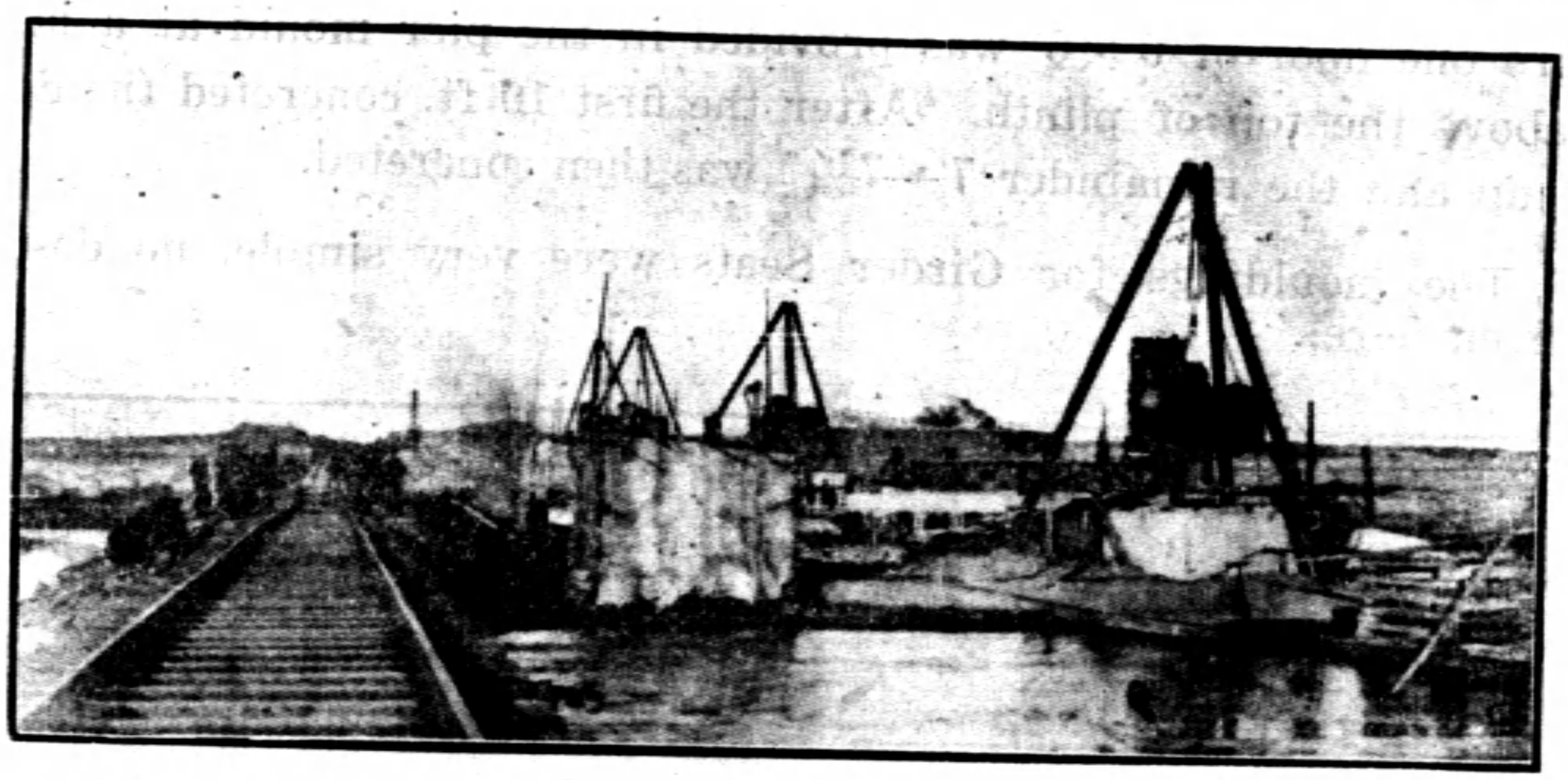
After the setting of the sealing concrete, the pressure was gradually reduced and one fitter got down to loosen all the nuts, and take off the bolts at the bottom joints (B in Fig) of shaft pipe. The pressure was now cut off entirely and air lock taken away. The shaft pipes were lifted up in whole piece and taken off length by length from top. At this time some water was still left in the shell, which would help the sand fillings afterwards to better settlement. The sand excavated from the sinking work now was used to fill the shaft whole in foundation shell. When water seemed too much, it might be bailed out. The sand core was filled to a height 2 or 3 ft. below the top of concrete foundation shell so as to leave room to form a key with the substructure castings.

A total sinking of 556.41 lin. ft. for the 13 foundations was done in an interval of 120 days with an average progress of 4.63 ft. per 24 hours. Most of the 13 foundations were found a few inches off center line, inclining towards the down stream side inspite of various means having been tried for their correction.

CAISSON SICKNESS:—A weak fellow must not be subjected to work under air pressures. Any ulcerated part in human body subject to heavy pressure will be swollen. When one gets into the first door of air lock and is going to open the second door, he should open the valve for second door slowly, meanwhile he should keep a good pressure in his body by closing his mouth, holding his nose with fingers, and trying hard to exhale until his ear drum feels something. The second door can be opened now and he may go to work. For the first time, he has better to go in under a low pressure. If the pressure has been too great for him in opening the valve to second door, he must close the valve right away and open the first door, getting off. Don't try any more. Since the strata we worked through are of fine sand and porous and the dirty air in chamber under high pressure always finds its way out and fresh air coming in, our workmen didn't suffer so much as in a sticky clay or some other air-light strata; hence only a few got trouble developed and one assistant foreman got sick who went into the air lock when having a headache.



(E) Temporary Engine House at North Bank



(F) Temporary Boiler House (Courtesy of Mr. K. S. Chu)

The air pressure in working chamber varies with the depths below water line, and usually a little greater than the pressure required to keep out the water. The highest pressure had been used here was 27 lbs. per sq. in. when 45′ below water line.

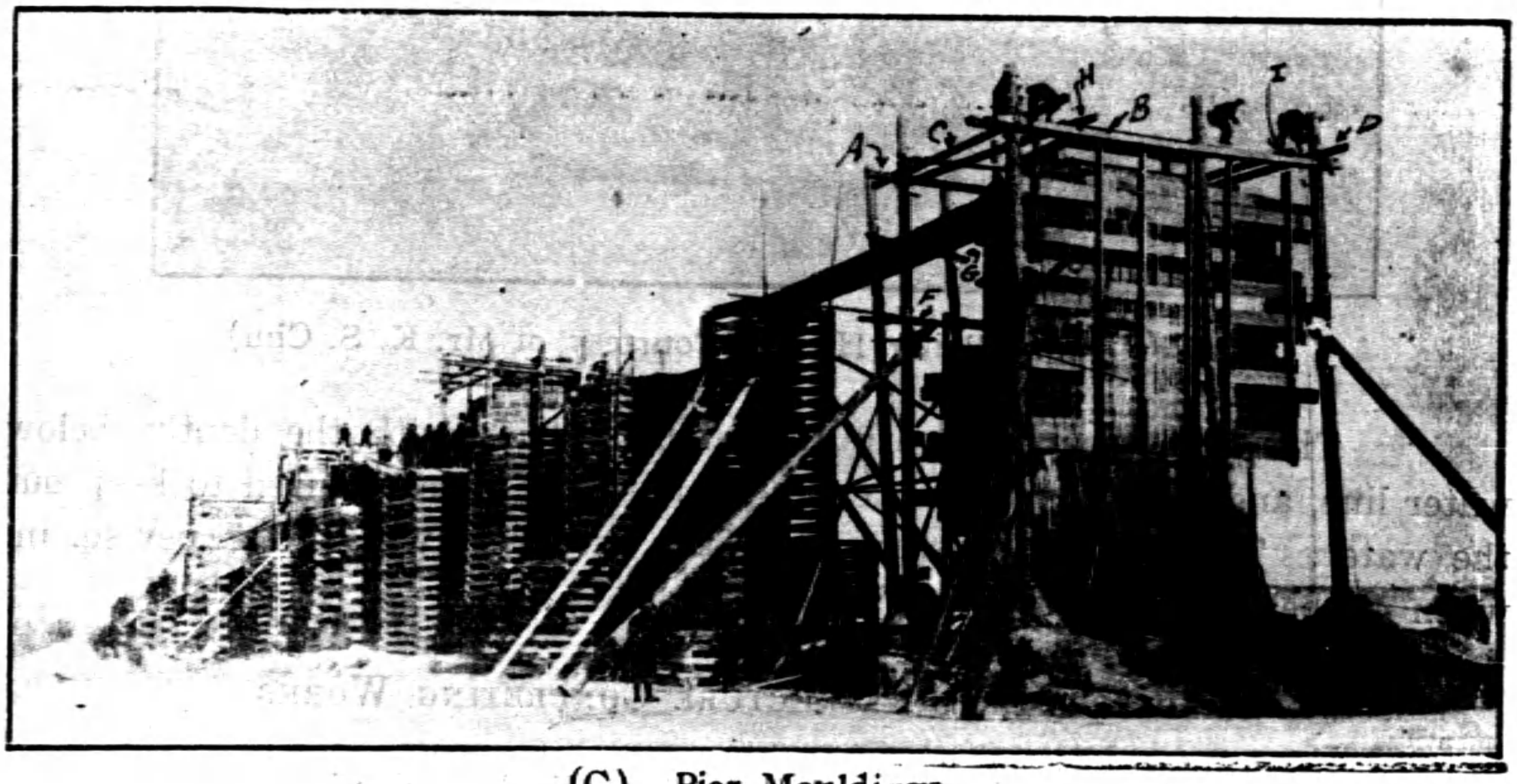
Chapter VI. Substructure Concreting Works

MOULDINGS:—The mouldings for plinth and pier were built in the same cheme;—there were two unit piece for each round end made of 2″×6″ oregon planks with the grain vertical. Circular rims at 2′-1″ apart used as waling pieces were cut from 3″ planks and strengthened with iron sheet in junctions. The moulding for the two straight faces were made of separate pieces of 2″×12″ planks, with grain horizontal, nailed to the vertical bracing posts at every erection. The two large pieces of moulding thus made were held togather with ⅝″ or ¾″ round iron bolts at 2′6″ apart through the vertical bracings. Small wooden pipes were first used to protect the bracing bolts from concrete inside the mouldings. This was found too expensive in cost and unsatisfactory in service. Then we tried to utilize the old, or say wasted, 1½″ boiler tubes for said purpose and found it satisfactory.

When wet concrete mixture is poured from a too high position the aggregate may have chance to drop first due to its higher specific gravity and separated from the finer material, cement mortar. Under such conditions the concrete will not be so good. As the pier mould was 17′—7¼″ high it was not advisable to pour the wet mixture from top when concreting the lower 10 ft.

Therefore one door of 6′×6′ was provided in the pier mould at a height of 10 ft. above the top of plinth. After the first 10 ft. concreted the door was blocked up and the remainder 7′—7¼″ was then concreted.

The mouldings for Girder Seats were very simple, no description being given here.



(G) Pier Mouldings

SCAFFOLDINGS:—For a low concrete structure it is very simple. Now is described something about scaffoldings for concreting the high piers, the highest of which, including a few ft. of foundations in river bed, was 37ft.

At each of the four corners a 40′ round pile of 12″ dia. was erected 2 or 3 ft. away from the pier proper. To each of the four posts another 35′ pile was tied obliquely with a convenient angle as a support to hold the posts in position. In the winter time we tried to protect the footings of posts by pouring water and dirty around, the frozen action of ice being found satisfactory. Two pcs. 28′ telegraph wire poles of 6″ dia. were horizontally fastened to top of the 4 posts at both sides as beams; and 2 pcs. 4″×6″×17′ logs at both ends as bracings. In addition, 2 more 40′ poles were erected at both sides of the door in pier mould, with the tops tied to the beam A and their duty was twofold;—one to strengthen the top beam A to a shorter span; the other as posts to receive a short beam E 4″×6″×9″ for the gangway at the sill of mould door. In the back side another additional 40′ pole was erected in middle of the two main posts, strengthening the other beam B, too.

(H) Scalfolding to Pier Moulds
(Courtesy of Mr. Y. Y. Wu)

The gangway for concreting was 6 feet wide, consisting of 6 pcs. 3"×12" oregon planks. At the sides railings were provided along on the higher position by means of ordinary scaffolding poles. The planks of gangway was supported by sleeper stacks underneath at 10 to 14 ft. clear spans. The slope of gangway varies from 1:3 to 1:5 but the former only adopted for short distance, otherwise the workmen could hardly walk up with their loads. In concreting the No. 4 pier the gangway was as long as 200 ft. in 1:5 inclnation. This haulage was a hard task. As you understand from the previous articles one door in the pier mould was provided for concreting the lower 10 ft.; and you understood also the concreting for such whole piece of work should be cast in one continuous piece, junctions being not advisable, our gangway must be built accordingly to facilitate the 3 pourings (i.e. before and after the blocking up of mould door) without wasting much time for its doing before the set of first casting. Therefore, sleeper stacks were not put under the first and second spans near door, bur, but 2 pieces of 35′ round pile were erected with horizontal beams F and F for the supports.

For the first casting the gangway was placed on the beam F and led to the sill of mould door on beam E. (not visible in Fig.). As soon as the first casting finished the gangway planks were lifted and supported on the upper beams G and A, meanwhile the door of mould blocked. Such change could easily be done within one hour or less.

Most of our concrete work was done in the severe cold winter, means to heat the concrete was necessary. Salt was dissolved in water at 13½ to 18 lbs. per fang of concrete, or say 0.5 to 0.8 lbs. salt in every cu. ft. of water, and the water heated in two toubs of tip cars. The sand was heated on steel plates, too. Besides, the moulds were covered up with straw curtains all around. Concrete thus cast was proved to satisfactory, except 1 or 2 inches some part in the surface, as shown in later test.

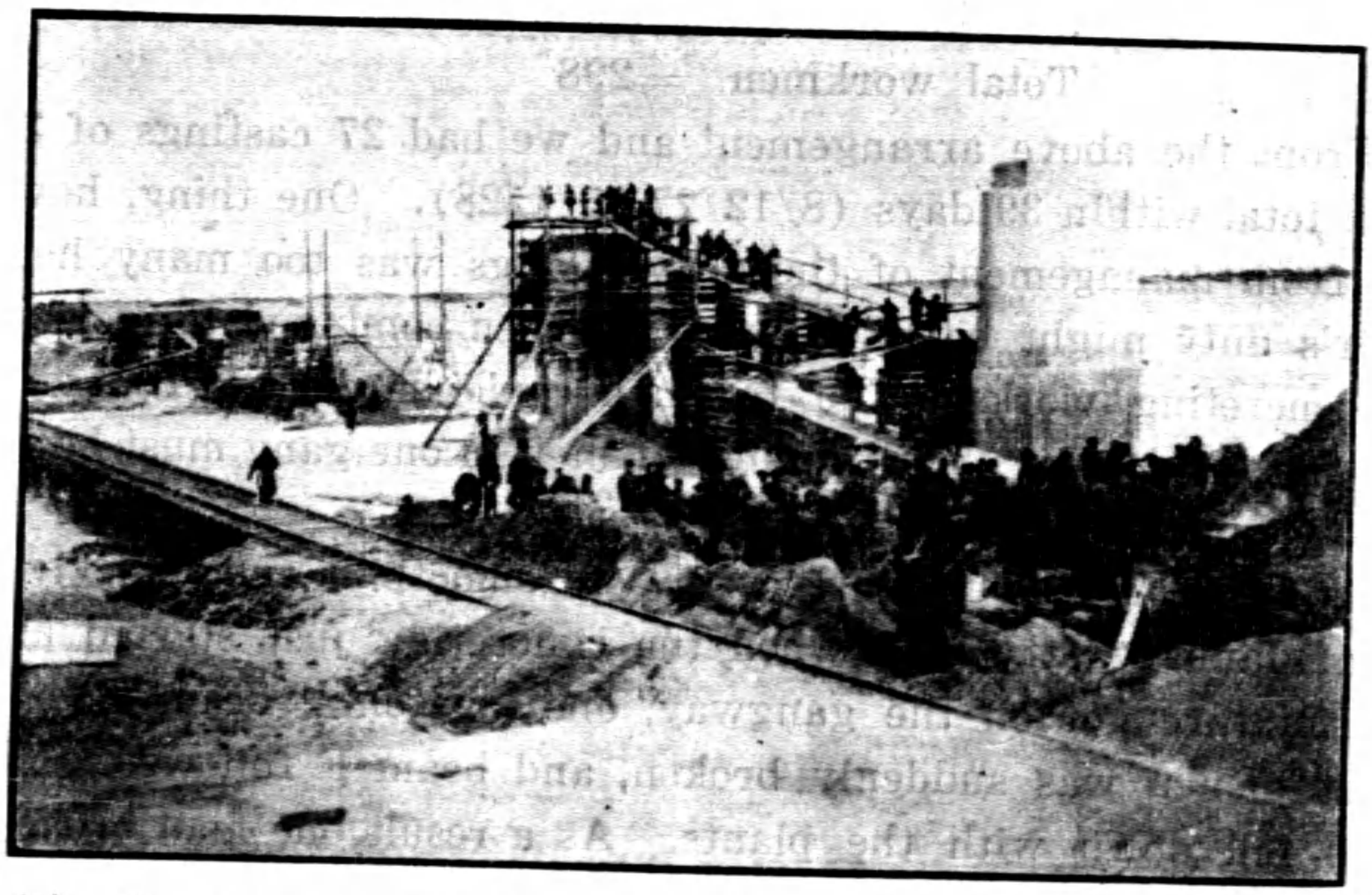
The duties of workmen for concreting the high pier (18.5 fg.) in one day were arranged as follows:—

4 water men carrying water from river to working site.
4 fire men heating the water and sand.
4 men pouring ballast and sand on mixing plate.
6 men loading ballasts to measurement.
*10-16 men to shifting ballast when far from plant.
3 men loading sand to measurement.
*6-10 men shifting sand when far from plant.
3 men proportioning cement and sand.
1 man pouring water to dry mixture.
8 men mixing wet mixture by shovals.
4 men loading wet mixture to carrying baskets.
32-48 men carrying wet mixture to moulding.
4 men pouring concrete mixture into moulding.
4 men in 2 shifts ramming concrete in moulding.
3 carpenters watching the mouldings
*6-10 men for all the miscellaneous work not mentioned above.

Thus a total of 132 to 80 men would be required to do the concreting work. *indicates optional.

GENERAL PROCEDURE:—Center line is one of the most important factors in bridge works, and should be marked out and checked before and after every casting. As said before the concreting of low structures are comparatively simple and easy, and no description is necessary. Now some remarks are made to the high piers. To begin with, the 4 vertical posts (40' piles) were erected and the 4 beams A, B, C and D then lifted and tied to the tops of them. Two extra 4"×6×16' cross beams H and I were placed on beams A and B, and on top of H and I, 4 pieces of 3"×12×30" planks were placed. Carpenters then could get on and the vertical bracings hung up to the planks; the moulding erection thus going on. Meanwhile one

25 men gang were doing the scoffoldings for mould and another gang of similar numbers doing the sleeper stacks and the gangway. When materials all ready 20 carpenters could finish the erection in 3½ to 3 days, while all the scaffoldings by other gang 2-4 days. Many other gangs engaged at same time to handle materials, fixing plant, for concrete; stripping old concrete moulds; and running a lot of other miscellaneous concerned there-by. When all the things ready, the concreting was started in morning and all efforts tried to complete the whole casting in that day. As the work was done in the severe cold weather great care must be exercised. Be sure to get concrete well rammed. Sometimes the wet mixture froze already before poured into forms; thorough ramming is the only means to recover it. When set, not much strength reduction.



(I) Concrete plant & Concreting (Courtesy of Mr. Y. W. Liang)

In concreting, 2 or 3 carpenters were in charge of detecting any movement to the forms; and tried all means to ellimmate or correct them. One thing which required our special attention here is not to let any single piece of the scaffoldings get in touch with the mould; thus the latter would not be affected by any movement of the scaffolding poles or planks caused by the live load of workmen.

After the casting was finished the concrete must be well protected from cold by means of straw curtains. As the concrete was of a big mass, and as the work was in hurring, the moulds were taken off only in one week even in the so cold weather. It gave no sign of great defect.

ARRANGEMENT OF WORK:—There were only 4 sets of pier moulds, and 2 gangs carpenter for erection and taking off, and the work so hurried that concreting had to be done in every other day. Any arrangement must be an economical one. Every gang was engaged to do the duty at his best and all the different parts of work were not supposed to interfere with or wait for each other. Total men engaged for the whole piece of concreting work were as follows:—

1	gang,	bosun @ 25 men	=25
4	„	general @ 25 men	=100
5	„	„ @ 20 men	=100
1	„	„ @ 15 men	=15
2	„	carpenter @ 25 men	=50
2	„	blacksmith @4 men	=8
		Total workmen	=298

From the above arrangement and we had 27 castings of 321.45 fg. concrete in total within 39 days (8/12/27-25/1/28). One thing, however, experienced from management of the above gangs was too many headed that the ganger's duty might be likely evasive when combined to work the large piece of concreting works. The foreman could hardly get control of them. This was not advisable. The number of men in one gang must be in proportion to the volume of work.

ACCIDENT:—Our work went on smoothly and quickly. In the morning of January 6th, 1928 when the concreting just started and 8 men with wet mixture got on the gangway, one horizontal beam E of the scaffoldings at pier 9 was suddenly broken, and beam F followed. The 8 men with loads fell down with the plants. As a result one man broke his right shin, one man was badly wounded at his rib and 5 men hurt slightly. After close examination as to the cause of accident it was found the broken piece was orverloaded. From this we learned that close examination of the important members should be made every time although it had been used safely for so many times.

TEST OF CONCRETE:— 72% of the substructure concrete work was done in the severe cold winter with minimum temperature of 24½ degrees and a maximum 6 degrees Centigrade below zero, under shade of building. A much lower temperature must be in the open field and on icy river.

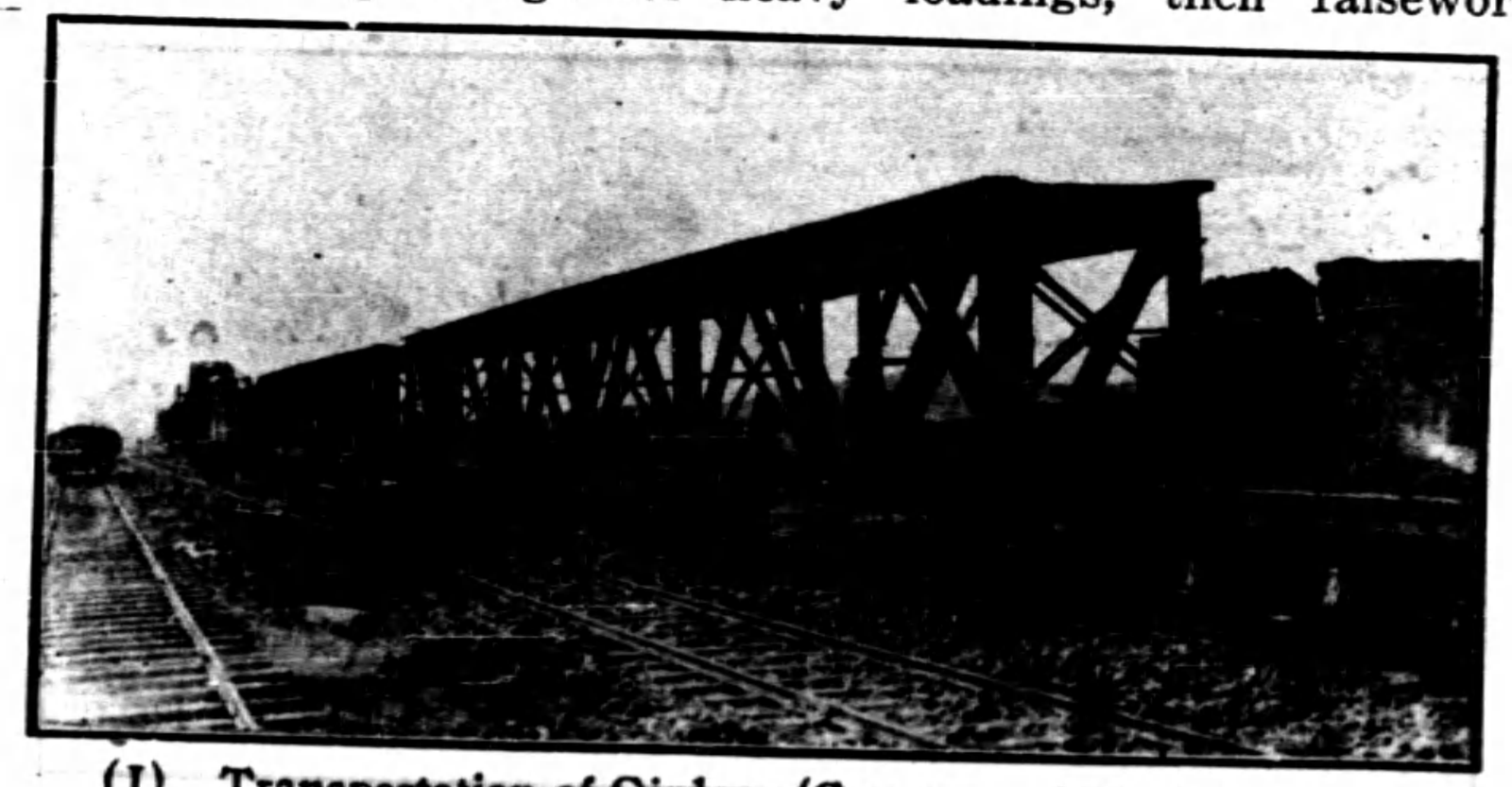
In taking off the moulds it was found a few inches concrete frozen in the surface while the tie bolts, being taken out from mould, smoky vapors

curling up, showed much heat had been evolved from the concrete inside when set. The surface frozen concrete after moulds were dismantled melt under sun light and then set.

All the castings were satisfactory except the surface of the 11th pier which looked rough and loose. This was traced to the carelessness in ramming during concreting. The pier was then chiseled for examination and test. Pieces of sample concrete obtained from a hole of 12" depth. It looked white and loose and its tensile strengh was found from 60 to 80 lbs. per sq. in. But after the samples were submerged in water 4 hours its tensile strength increased to 180—220 lbs. per sq. in. approximate. The test was not accurately done as the samples were not in testing briguett forms. It convinced us, however, that the aggregate will be continuing to set and will be stronger when they are moistured in the raining season. After the raining season the piece No. 11 was examined again. The concrete of the inner part proved as sound as other castings. Concrete at 1" to 1½" in surface showed a reduced strength. Our conclusion was this, Massive concrete can be cast in the cold winter and just as good provided well protected and rammed.

Chapter VII. Girder Erection

FALSEWORK:—As the girders were put on in whole piece, the main part of falsework was to span over the opening for track, over which the girder erection crane would run. The erection work was done in the cold winter; we had good reasons to utilize the river ice (see explaination later). It was then decided to use sleeper stacks for the falsework. Should the ice not be strong enough for heavy loadings, then falseworks must



(J) Transportation of Girders (Courtesy of Mr. K. S. Chu)

come in to play. Clear span 100 feet; ground surface to the top of rail level in the highest port 41 ft. But up 7 sleeper stacks in each span, giving a clear space between stacks 7'-6". On top of the stacks 4-12"×12" oregon logs (preferrably to have different lengths say 50 feet, 30 ft. and 20 ft., so as to make good interlocking), laid horizontally two under each rail, bridged over the openings. The width of stacks was of 4, 3, 2 and 1 sleeper length. Space between stacks was also interlocked with sleepers in one or two parts near the top.

One sleeper stack consisted of 1008 pcs. new oregon sleepers in the highest openings; a total number of 7100 pcs. sleepers required for one span. It was so arrange that one 20 men gang to do the work for one stack only while the bridging work by an exgra gang. By competition the work was getting on with rapidity; on average, the stacks and bridging work for one span can could be done in every two days.

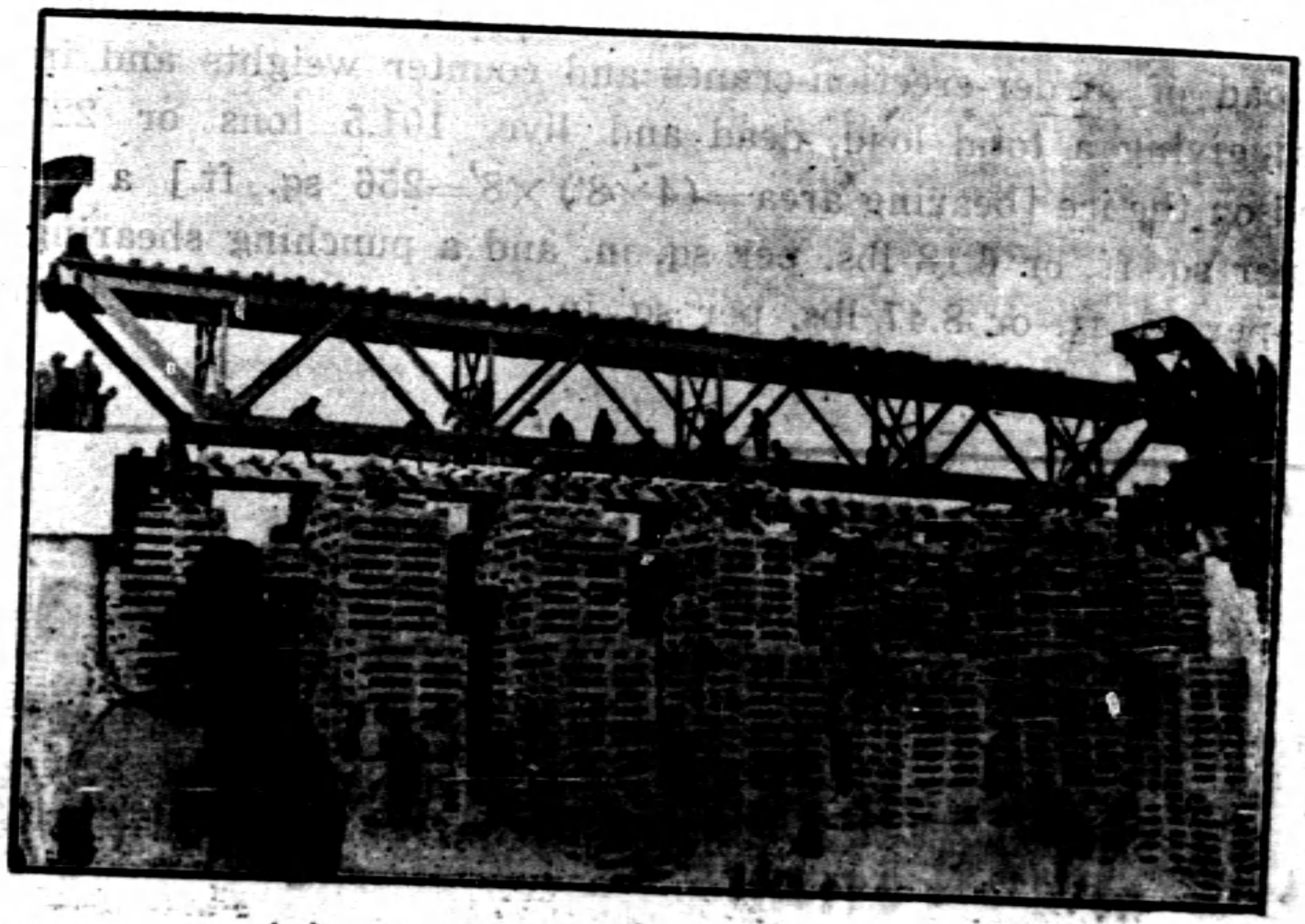
GIRDER TRANSPORTATION AND ERECTION:—The E.-35 girder on Hsiao Ling Ho bridge was lifted up by a pair of girder-erecting-crane, where new girder of E.-50 was replaced. The old girder was then transportated to and unloaded at the nearby stations of Liu Ho by means of a pair short borgies which were specially designed and constructed by Dr. Chen Hua, Manager of Engineering Department Works, Shankaikwan.

The girder-erecting-cranes were also constructed by Dr. Chen's design. They can carry and erect girders up to E.-60 100 ft. spans. The whole girder was suspended at both ends by means of differential pulleys and wire ropes connected with the davits or goose necks which are supported by a three-wheel borgic of 12 ft. long and balanced by counter weights resting and tied on a 32' flat car attached behind.

(K) The Girder-Erection-Crane (Courtesy of Mr. K. S. Chu)

When falsework was ready, the girder was suspended again to the girder-erecting-cranes and moved to site. The locomotive should push instead of pulling the cranes this time as a precaution to any accident to the false work and possible damage to the Engine. As soon as the girder suspended was well adjusted in position above the piers, the temporary track was taken off; and the sleeper stacks dismantled to afford sufficient room for lowering the girder which was done by means of the pulleys, wire ropes, and winches on the cranes. After having lowered the girder on the piers track was laid on the girder just erected. The erection of one girder finished. Counting from the minute when the suspended girder adjusted in position, it takes 10 min. to remove the temporary track; 20 minutes turn down the 8 pieces of 50′ logs; 15 minutes dismantle the sleepers from top of stacks to a 12′ depth; 20 minutes lower down the girder on piers; and 40 minute put back the track. Total length of time required to erect one girder was about 1¾ hours. We erected the last 3 spans in one single day on the 9th of March 1928 including travelling 1¾ miles to fetch the girders from Chang Wu Hsien station to working site.

RIVETING:—88 pieces of rivets on each span of the girder were chiseled off for the transportion's sake. Now they were required to be put



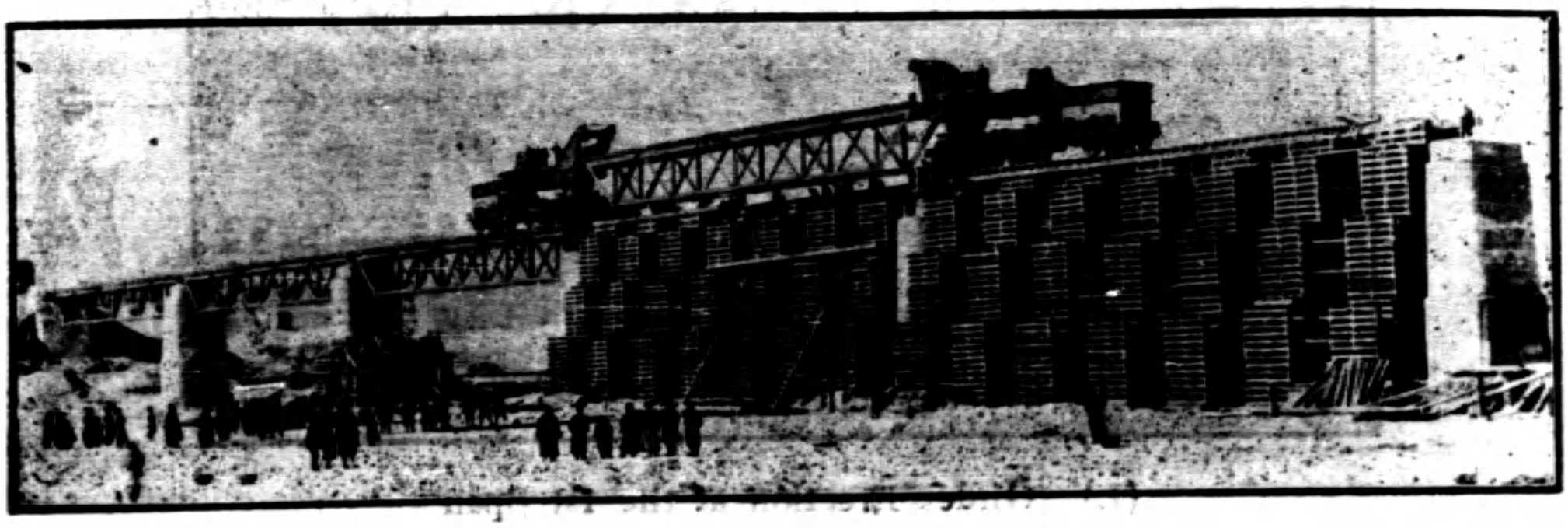
(L) Girder Erection at the 1st Span
(Courtesy of Mr, K. S, Chu)

back. The riveting was done by pneumatic hammers. The pressure was supplied by an air plant mounted on borgies in the form of covered car while air compressor was run by steam supplied from a locomotive engine attached to. The whole gang 15 men including the ganger No. 1 and fitters could complete 3 spans in one day.

DECKING AND OPENING BRIDGE TO TRAFFIC:—Bridge ties 8″×9″ or 8″×10″×10′ were spaced at 19″ c. to c., making a total of 67 pcs. on each span. The decking started on 5th March 1928 and finished on 17th of said month by a gang of 25 carpenters: of course, the planking bridge ties not included. The bridge work was started at end of April 1927 and bridge opened to traffic on 20th March 1928 work suspended in July and August 1927 covering a period of 9 months.

RELATION OF ICE TO THE WORK:—Sleeper stacks in the 2nd, 4th, and 6th spans rested on the solid ice while those in the 3rd and 5th on the ice right in the water way with a few inch to 1′ 6″ flowing water underneath; the rest of the spans being directly on solid ground. Now it is considered if the ice is strong enough to bear such heavy loads.

One sleeper stack consisting of 1008 new oregon sleepers including portion of logs, temporary decking track etc. weighs 49 tons, together with the live load of girder-erection-cranes and counter weights and impact etc. 52,5 tons; giving a total load, dead and live, 101.5 tons or 227,000 lbs. This acted on the ice [bearing area=(4×8′)×8′=256 sq. ft.] a pressure of 890 lbs. per sq. ft. or 6.18 lbs. per sq. in. and a punching shearing force of 1220 lbs. per sq. ft. or 8.47 lbs. per sq. in., the ice being 2′-4″ thick at that period.



(M) Girder Erection at the 4th Span

(N) Whole View of Bridge after girder erection (Courtesy of Mr. K. S. Chu)

With regard to the strength of ice some German experiment made in 1885 gave a tensile strength of 142 to 223 lbs. per sq. in. Test made by U.S. engineer corps in 1880 gave crushing strength 100 to 1000 lbs. per sq. in. Railway trains have been run across ice when was 15 inches thick (see American civil Engineer's hand-book). In the experiment made on Sungari river ice which was 29½ inches thick it was reported that trains of 120 tons could run over, with a speed of 12.5 miles per hour, 7 round trips in one day for a period of 19 days; that the shearing strength was about 10.5 lbs. per sq. in.; and that the loading on ice had a close relation to the length of time (see Mr. S. T. Chang's writing Vol. IV. No. 2 of the Journal). Our ice was thick enough and the erecting-cranes would pass only once with exceedingly low speed. Furthermore, the span of ice slab in our case was very narrow. It was very safe therefore for us to take the chance of utilizing the ice to support the falseworks to erect girders at Liu Ho. We were, however, after all bothered a little bit by the ice. On 19th Feb. 1928 one day before the erection of 4th span, water sprung out of the ice at upstream about 2 miles to the working site, and flew in a layer of 12 inches. The whole river was then flooded. It was noticed the ice under flowing water in the moon time could melt down 1 inch per hour. Fortunately, some precaution had been taken soon after the water gave appearance and it was diverted to flow through the second span. So only a little water get under the sleeper stacks in the 4th span. We decided without hasitation, to take a chance of the frozen action in night, to erect the girder by the early morning of next day and luckly got over safely. Now the weather got warmer; ice melted from upper surface, and flood water tried to melt the ice underneath. In putting up the falsework of 6th span 6—12″×12″×50′ logs were placed as a base to interlock the whole span so as to prevent partial yielding of ice. No sign of weakness was noticed after all. Our great anxiety was over after the erection of this girder. Then the work went on smoothly without any trouble.

Chapter VIII. Protection Works

The contruction of the protection works is simple and no much explanation is required. But a little remark may be made as follows:—

The concrete footings were at begining designed as solid block of 5′×5′×10′ but it was found afterwards that expensive means was required for its construction as the soil was quick flowing sand. It was then decided to make the concrete blocks hollow inside in the form of an open well with cutting edges underneath, the inside dimension being 3′ × 7′ × 5′. When the founds excavated to water level, one heap of earth was trimmed and rammed in the center to form the cutting edges of well as if the core in foundry. Outer and inner moulds were erected and well concreted. After moulds were dismantled sinking by open excavation began. The sinking, however, was going on not without troublesome from the flowing sand although it was done only 5 ft. below water line. When the well sunk home, the same question arose again for the filling. It was tried hard to get the sand off, showing the cutting edges of well before filled but this was never successful. The quicker you dig out the inside sand, the faster the sand flows in from the bottom and all the sand outside well tries to cave in. If by chance the incoming rate is overtaken by the digging out, the well sinks down whole piece, but edge still could not be cleaned out. The filling in the case could only be done to a depth of 4 ft, leaving the lowest one ft. to sand.

At last the quiet water in the wells led to the discovery of a better result. When wells were cleaned for filling, don't bail out all the water inside, just keep it say 2′—6″ for a working condition. The inside sand was then cleaned under water, the head pressure of which keeps the quick sand from flowing in. As soon as the edges of the well is well cleaned, pour in a layer of concrete ballast 5″ thick. Then bail out the water and fill in concrete. A filling of 4′—9″ deep can be secured without much labor wasted. Of course, open dredging and concreting under water are the proper ways to do such kind of work; but the process would be to expressive.

The work was done first by time labor and contracted out later on, Due to the civil war the completion of such protection work was delayed until 20th of September 1928.

Chapter IX. Cost Data

The cost of this bridge construction works was generally classified and numerated per the following lists:—

(1) Cost of Materials, including all the charges for materials, tools, and depreciations of machinery of air plant and girder erection.

SIDINGS (temporary bridge T.B.)	$ 2,585,23	$ 2,585.23
SINKING WORKS:—		
—Engine house (Sw-eh)	$13,798.41	
—Moulding (SW-m)	$ 2,347.82	
—Concreting (SW-c)	$21,601.42	
—General (SW-g)	$30,475.69	
Sinking plant depreciation ×		
@ 6% of $100,000	$ 6,000.00	$ 74,223.34
BRIDGING WORKS:—		
—Moulding (BW-m)	$ 3,282.69	
—Concreting (BW-c)	$14,841.16	
—General (BW-g)	7 2,962.35	$ 21,086.20
GIRDER ERECTION (GE)	$78,095.68	
—Machinery depreciation @ 5% ×		
of $30,000.00†	$ 1,500.00	$ 79,595.68
PITCHING WORKS (PW)	$10,113.44	$ 10,113.44
GROSS TOTAL		$187.603.89Y
LESS the total sum of materials credited back from the bridge works		$ 20,422.72
NET TOTAL		$167,181.17

REMARKS:—The sum "Y" $187,603.89 less the depreciation values "×" $7,500.00 giving $180,103.89.

†Cost of the girder-erection-cranes.

(2) Cost of labours, including all the charges for time contract and The Engineering Works labours.

SIDINGS (The deviation and temporary bridge):—

	Piling	$ 802.24		
	Temporary bridge	$ 834.77		
	Handling materials	$1,164.98		
	General works	$2,005.21		
	Maintanence (clean sand)	$3,330.00		
	Taken off	$ 594.15		
	Watching service	$ 414.65	$9,146.00	$9,146.00

Boring:—

	Boring the river bottom	$ 473.67	$ 473.67	$ 473.67

SINKING WORK (The foundation):—

Sw-eh	Carpenter work	$ 555.20		
	Fitters care for the engine	$ 485.02		
	Common labourrs	$1,278.74		
	Repairing air plant by EDW	$1,500.00	$ 3,818.96	
-m	Carpenter work	$3,560.59		
	Iron work	$1,138.04	$ 4,698.63	
-c	Scaffolding and Concreting	$9,965.22	$ 9,965.22	
-g	Making dams & cleaning founds	$1,745.16		
	Handling materials & plant	$5,497.80		
	Sinking force by contractor	$9,215.95		
	Watching service	$ 314.42	$16,773.33	$35,256.14

BRIDING WORK (The substructure):—

BM-m	Carpenter work	$3,004.86		
	Iron work	$ 843.60	$ 3,848.46	
c.	Scaffolding for concreting	$1,896.28		
	Conereting	$4,998.41	$ 6,864.69	
-g	Handling materials	$2,157.76		
	Watching service	$ 374.89	$ 2,532.65	$13,275.80

GIRDER REECTION (The super-structure) :—			
Sleeper stacking	$2,537.63		
Track laying	$ 370.00		
Erecting operation by EDW men	$1,800.00		
Decking the bridge	$1,137.95		
Painting the Br. 2 coats	$ 514.95		
Watching service	$ 85.00	$ 6,445.13	$ 6,445.13
PITCHING WORKS (The protection works) :—			
Daily labours	$9,180.10		
Contract force	$5,873.15		
Watching service	$ 223.24	$15,276.49	$15,276.49
TOTAL			$79,873.23

(3) Supervision Expenses, including only those charges for the supervisors directly concerned to the works such as engineers, foremen, clerks and store staffs and etc.

Salaries and allowances	$16,640.04	*Note*: The expenses for police protection not included herein.
Engineer and staffs quarters	$ 1,450.51	
Office accommodation	$ 287.84	
Office expenditures	$ 248.23	
Store salaries & allowances	$ 3,578.94	
Store other expenditures	$ 1,530.51	
Hospital salaries and all	$ 254.14	
Hospital other expenditures	$ 63.00	
TOTAL	$24,053.21	

(4) Freight services, including the charges for material transportations, use of cars and locomotive engines.

***Material Car-Mileages*:—**

Where from	No. of cars & its contents	Km. to Liu Ho	Car-Km.
T. N. (唐山)	81 (Cement & Mis. Materials)	549.58	44,516
S. H. K. (開灤山)	49 (Caissons & Mis. Materials)		
	20 (Air plant machinery)		
	20 (Air plant machinery return)		
	40 (Sleeper return after girder erection)		
	129	406.67	52,460

P. P. (北 票)	91	(Coal and Mis. Materials)	325.72	29,640
Y. K. (營 口)	33	(Sleepers and Mis materials)	240.91	7,950
K. P. T. (溝幫子)	15	(Sleepers and Mis. materials)	149.66	2,245
C. C. N. (趙家屯)	230	(Sand)	141.14	32,462
H. L. N. (新立屯)	10	(Mis. materials)	48.60	486
		TOTAL		169,759

K. C. T. (郭家店) 1478 (Quarry materials, by allocated car) 9.17

NOTE:—All the cars of 20-ton capacity.

Freight charges (In approximation only):—

169, 759 car-Km. or 3,395,180 ton-Km @ 0.3 cts.=$10,185.54
1,478 20-ton allocated cars @ $2.0 per 24 hr=$ 2,956.00 $13,141.54

Locomotive engine charges for use (In approximation only):—

148 trains quarry materials from K.C.T. @ 3 hrs. for a round trip.....	444 hrs.	
Shunting works at av. 1 hr. per day for a period of 11 months	330 „	
Girder transportation from Hsiao Ling Ho 12 spans @ 16 hr. each	192 „	
Girder erection 12 spans @ 6 hrs	72 „	
Supplying steam for riveting 12 span @ 6 hrs. each	27 „	
Total	1110 hrs.	
1110 working hours @ $5.00 per hr.	$ 5,550,00	$ 5,550.00
TOTAL		$18,696.54

The TOTAL COST of THE BRIDGE is then the summary of the above four items (the charges for telegrams, consignment notes, free passes, police protections, and a lot of others such as taxes, costum duties, etc., etc. not included here. They must be included should the bridge not be constructed by the Government) and summed up as folows:—

(1) Materials	$167,181.17
(2) Labours	$ 79,873.23
(3) Supervision Expenses.....	$ 24,053.21
(4) Freight Service	$ 18,691.54
GROSS TOTAL	$289,799.15

The AVERAGE COST of different parts of the BRIDGE WORK is tabulated in the following lists:—

a. Bridge Opening cover all per ft. run (Including Supervision & Freight)—
The bridge clear opening is 1200 ft. run @ av. cost
$289,900.00/1200=$241.50 per ft. run.

b. Bridge Opening per ft. run (Excluding S. & F. charges) @ av. cost

Material	$167,181.17/1200=$139.32	per ft. run
Labour	$ 79,873.23/1200=$ 66.56	„ „ „
L. & M.	=$205.88	„ „ „

c. Foundation Work per ft. run of bridge opening (Excluding S. & F. charges):—

@ av. cost

Material	$74,223.34/1200=$61.85
Labour	$35,256.14/1200=$29.38
L. & M.	=$91.23

d. Pneumatical Caisson Found tions per lin. ft. depth (Excluding S. & F.):—
@ av. cost

Material	$74,223.34/601.46 or $123.41	per lin. ft.
Labour	$35,256.14/601.46 or $ 58.61	„ „ „
L. & M.	$182.02	„ „ „

e. Concrete of Foundations per fg. (Exc. S. & F.):—
1 lin. ft. of foundation or solid mass has 219.66 cu. ft.
1 lin. ft. of foundation for sollow shell " 191.25 cu. ft.
Total volume of concrete is $219.66 \times (13 \times 9.42) + 191.25 \times (601.46 - 13 \times 9.42) = 118,508.31$ cu. ft. or 1077.35 fg.

@ av. cost

Material	$21,601.42/1077.35 or $20.05	per fg.
Labour	$ 9,965.22/1077.35 or $ 9.25	„ „
L. & M.	$29.50	„ „

f. Moulding for Foundation concrete per fg. (Excluding S. & F.):—
@ av. cost

Material	$2347.82/1077.35 or $2.18	per fg. of concrete
Labour	$4698.63/1077.35 or $4.36	„ „ „ „
L. & M.	$6.54	„ „ „ „

g. Sinking Force per lin. ft. of foundation (Excluding S. & F.):—
@ av. cost

Labour only $9215.95/556.41 or $16.51 per lin ft. sunk
Labour only $9215.95/556.41 or $16.51 per lin. ft. sunk.

h. Air Plant, boiler-hours per lin. ft. of sinking (Exc. S. & F.):—
The total boiler-hours used for the whole sinking job of 556.41 lin. ft. of foundation is 12,475 (See Appendix 5. p. 65).
@ av. value 12475/556.41 or 22.39 boiler-hrs. per lin. ft. sinking.

i. Coal consumption (Pei-Piao Lump coal) per lin. ft. of sinking (Exc. S. & F.):—
The total coal consumption for the sinking of 556.41 lin. ft. of foundation is 1489 tons Pei-Piao lump coal.
@ av. value 1489/556.51 or 2.676 ton coal for lin. ft. of sinking or
@ av. value 2.676/22.39 or 0.12 ton or 240 lbs. per boiler-hrs, agreed with the limited quantity as stated in the contract.

j. Substructure, Bridging Work—for 100 ft. span, 33 ft. piers—per ft. run of bridge opening Excluding S. & F.):—
@ av. cost

Material	$21,086.20/1200 or $17.57	per ft. run
Labour	$13,275.80/1200 or $11.06	„ „ „
M. & L.	$28.63	„ „ „

k. Concrete of Substructure per fg. (Excluding S. & F.):—
The Total quantity of concrete for the substructure is 170.6×134.18+13×2270.9+11×245.7+2×776 or 56,667.5 cu. ft. or 515.15 fg.
@ av. cost

Material	$14,841.16/515.15 or $28.80	per fg.
Labour	$ 6,894.46/515.15 or $13.38	„ „
M. & L.	$42.18	„ „

l. Mouldings for substructure Concrete per fg. (Excluding S. & F.):—
@ av. cost

Material	$3282.69/515.15 or $ 6.37	per fg.
Labour	$3848.46/515.15 or $ 7.47	„ „
M. & L.	$13.84	„ „

m. Superstructure for 100-ft. span per ft. run of bridge opening (Excluding S. & F.):—
@ av. cost

Material	$79,595.68/1200 or $66.33	per ft. run
Labour	$ 6,445.13/1200 or $ 5.37	„ „ „
M. & L.	$71.70	„ „ „

n. Girders only per ft. run of bridges opening (Exc. S. & F.):—
@ av. cost, Material & labor $68400/1200 or $57.00 per ft. run.

o. Decking per ft. run of bridge of over all length:—
@ av. Labour only $1137.95/12×106.5 or $0.89 per ft.

p. Decking per bridge tie (Inc. Guard Rails & refuges):—
@ av. Labour only $1137.95/804 or $1.41 per Br. tie.

q. Ratio of Labour to Material in whole
$79,873.23/167,181.17 or 47.7%

APPENDICES

Unloading big stones per car (20-ton car) $0.50
„ common rubble per car (20-ton car) $0.25
„ ballast, sand, or quarry rubbish per car $0.30
Shifting (by baby track) big stone at a distance between 150′ and 250′ per fang (110 cu. ft.) $0.50
„ common rubble at distance between 150′ and 250′ per fang (110 cu. ft).....$0.25
, Quarry rubbish within 150′ per fg. (110 cu. ft.)..$0.30
„ Quarry rubbish at distance between 150′ and 250 per fg. (110 cu ft.).....$0.45

CONTRACTING PRICES FOR SINKING WORK

1st price (including sand, gravel, clay, mud hard or safe, wet or dry, with separate stones large or small) @ $12.00 per linear foot.

2nd price (for rocks that can be renoved by picks) @ $16.00 for soft rock per linear foot & @$18.00 for hard rock per linear foot.

3rd price (for hardest rock, blasting necessary) @ $21.00 per linear foot.
4th price (open sinking, no air lock in use) @ $5.00 per linear foot.

TIME WORK RATES PER DAY

Engine drivers	$0.75	for 12	hours.
Fireman	0.60	„ „	„
Oilers	0.40	„ „	„
Coolies	0.40	„ „	„
Fitters	1.00	„ „	„
Fitter helpers	1.00	„ „	„
Blacksmith	1.00	„ „	„
Blowers	0.60	„ „	„
Bosun coolies	0.50	„ „	„
Sinkers working inside Caisson	0.60	„ „	„
Sinkers on temporary work outside	0.60	„ „	„
Common coolies	0.35	„ „	„

美國大發電廠一九二八年擴充統計

(譯 Power Plant Engineering 一九二八年十二月十五日一張延祥)

一九二八年一年內,美國大發電廠擴充者十一處,新建者五所,其電量之大,世無與匹,因錄如下,以備參考.

甲. 擴充廠名廠址		擴充新機總量	
1.	非　路 Philo Station, Philo, Ohio	3 - 62,353	KVA.
2.	聖路易 Cahokia Station, St. Lom's, Mo.	1 - 55,556	„
3.	平漢頓 Binghamton Station, Binghamton, N. Y.	1 - 35,000	„
4.	紐　約 Hell Gate Station, New York, N. Y.	2 - 94,000	„
		1 - 88,250	„
		1 -100,000	„
5.	密耳華基 Saginaw River Station, Milwaukee, Mich.	1 - 37,500	„
6.	堅克蘭 Station C.P.G. & E. Co., Oakland, Cal.	1 - 37,500	„
7.	哈　勒 Horseshoe Lake Station, Harrah, Okla.	1 - 37,500	„
8.	韋茅斯 Edgar Station, Weymouth, Mass.	1 - 75,000	„
		1 - 12,500	„
9.	卜羅楔 Hudson Ave. Station, Brooklyn, N. Y.	1 -110,000	„
10.	多倫拖 Toronto Station, Toronta, Ohio.	1 - 37,500	„
11.	詩家谷 Crawford Ave. Station, Chicago, Ill	1 { 38,825	„
		1 { 64,705	„
		4,666	„
		1 { 52,940	„
		1 { 64,700	„
		5,715	„

乙. 新建廠名廠址		新機總量	
12.	維愛那 Vienna Station, Vienna, Md.	2 - 7,500	KVA.
13.	浪僻區 Long Beach No. 3, Long Beach, Cal.	1 -100,000	„
14.	拜饑馬 Gould St. Station, Baltimore, Md.	2 - 43,750	„
15.	屈爾那特 Trinidad Station, Trinidad, Texas.	2 - 25,000	„
16.	崑　拿 Lake Pauline Station, Quanah, Texas	1 - 18,750	„

LIFTING AND REPAIRING OF YELLOW RIVER BRIDGE OF TIENTSIN-PUKOW RAILWAY

By Tsu Y. Chen.

FOUNDATIONS:—The region is entirely alluvial. The stream is notable for its shifting character. During dry seasons, the width of the River is practically confined under the cantilever span but in flood times from July to September, the water spreads out over the total width between the high water dikes. The clearance between lower chord of Bridge and river bed is varied from 7 to 8 meters. Hard, tough clay is only reached from 55 ft. to 65 ft. below lower water level. Therefore the foundations, bearing in temporarily jacking supports or sleeper stacks for the manoeuvering of jacks and carrying timber bents, were prepared in such a way that piling is not resorted to. Experience shows that compacted lime, sandy clay and gravel foundations with a depth of one meter will safely sustain a load of 2,000 lbs. per sq. ft. until next flood.

WEIGHT OF BRIDGE:—This bridge has an unusual feature of short length of cantilever arm in comparison with anchor arm. This eliminates the anchorages required at the piers carrying the ends of cantilever system. On account of this, the bridge was saved from serious damage due to the explosion on the ill-fated pier, otherwise the whole channel span might have dropped into the river. Structurally, this bridge is too squat for aesthetics and the proportioning of truss depths is far too small for economy. The amount of metal is rather extravagantly used.

From data on hand, the weight of Bridge plus track is 9,000 kg/m. for anchor and cantilever arms, and 8,700 kg/m. for suspended span. This makes the reaction at central pier 714 tons per truss and that at the end of anchor span 224 tons per truss.

LIFTING APPLIANCE:—Jacks of high capacity such as hydraulic or oil jacks enough to raise the dropping spans in single unit are not available except at great cost. In addition, experience shows that hydraulic jacks of high capacity are difficult to manoeuver and liable to accidents, while screw jacks, seldom if ever designed to lift more than 100 tons in single unit, are more reliable and easier to handle. Screw jack was chosen in preference to hydraulic, after a number of inquiries. Ten 100 ton and four 50 ton Joyce jacks were ordered from United States.

PROVISION AT POINTS OF SUSPENSION:—Owing to the dropping of anchor span due to explosion, the cantilever arm was tilted with its

fulcrum at center pier, causing an abnormal opening of joint where the suspended span connects. Pin plates and diaphragms were sheared off and bent. By further investigations, it is found that this does not constitute a state of danger as the load from the suspended span is transmitted through pendulum posts to the hangers of cantilever arms, and the pins are not designed to carry any load other than their specific purpose during erection. When lifting is applied under the anchor arm, the suspended span is supposed to return to its original position automatically. However, as a safety measure, two provisions have been devised at the points of suspension.

The first provision is by using ¾-in. diameter steel wire rope wound around the pin and a set of castings put against the bracket, which was originally provided for erection purpose inside the top chord of suspended span. The second is a Yoke device of I beam frame driven tight against the rocker casting of pendulum post with steel wedges. Both these provisions were designed for the same purpose and served to guide the closure of suspended span during the lifting of the anchor arm by tightening the wire rope in one and hammering the steel wedges in other.

PROVISIONS FOR MAINTAINING TRAFFIC:—The length of the Bridge and the great depth of the river combined to put the building of a temporary siding out of consideration. The possible solution to maintain a regular traffic is to let the trains run on the damaged spans with provisions that permit repairs be carried on with little or no obstruction, at the same time, the safety of structure kept uninjured. This resorted to a scheme that train load on its portion of the damaged spans be carried temporarily by a system of framed trestle bents, erected underneath the floor beams.

Although the exact nature of the distribution of stresses is rather uncertain, but it is quite sure that when the live load reaches these panels, the floor beams will first pick up and transmitted to the framed bents, leaving probably a very small portion to pass on to the main truss.

For the end panels of both spans, the wrecked floor system have been removed, and three units of temporary stringers supported on timber bents were erected in its stead, leaving plenty of working space for the remodelling of damaged pier.

All framed trestle bents were about five meters high, consisting of three vertical and two slanting posts, one cap and one sill, all of 12" by 12"

Oregon Pine, well braced diagonally by 12″×3″ planks. There were 19 bents erected and seated on sleeper stacks, whose height made to suit the underneath clearance between the floor beam and river bed.

These timber bents were not only used to carry the live load under traffic, but served as braces to ease the strain on the jacks during lifting. As the bridge was slowly lifting up, a fraction of a millimeter at a time, these traffic bents were also raised, by the addition of more sleepers underneath or inserting hard wood wedges in between floor beams and caps.

JACKING SUPPORTS:—Directly on each side of the damaged pier, four jacking supports, of heavier construction than the traffic bents, were erected upon compacted lime, sandy clay and gravel foundation. They were designed to take full dead load reaction of 272 tons plus one panel concentration of live load of 75 tons when the bridge is under traffic. The framed work consisted of six (16″×12″) vertical and ten (12″×12″) inclined posts with (12″×12″) caps and sills, well braced with diagonals and ties. They were mounted on a tier of 12″×12″ timbers and topped with a row of 250 mm. I beams, on which rest the battery of four 100 ton Joyce Jacks.

In addition to the jacking supports of heavy frame construction, there were auxiliary sleeper stacks built close to the damaged pier. A single unit of 100 ton jack or a pair of 50 ton jacks was placed on top of each, working simultaneously with the main lift. This served to support the overhanging portion of damaged span, and relieve considerably the stress in the joints.

LIFTING OPERATIONS:—The work was planned after a number of rehearsals. Signals, whistles and distribution of working force were all prearranged. When order was given for the starting of jacking, the cheering songs of workmen kept the timing of strokes in manoeuvering the jacks, winding the wire rope (at the point of suspension) and hammering the wedges (at the tops of traffic bents). This scene resembles very well of conducting a large symphony orchestra; verybody is working harmoniously with others. There was not a singlecase of discord reported nor a single accident happened.

The lifting of bridge was about 8″ to 10″ per day while the actual time spent on jacking only two or three hours. The rest of the day was spent in building up the staging, raising up the traffic bents (or braces), rearranging the grillages and resetting of jacks for next operation.

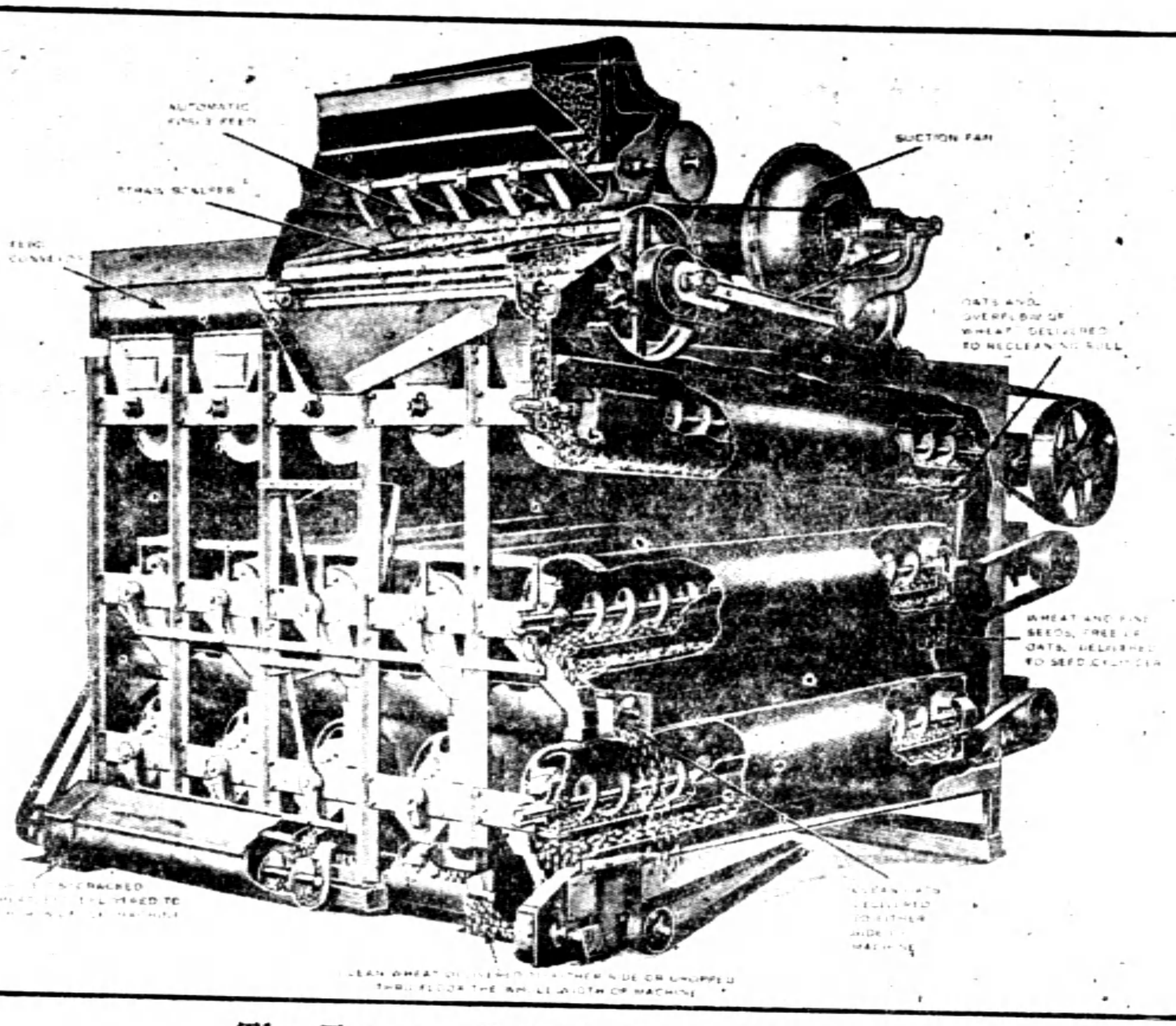
Instrument men have been stationed in proper place to record the raising of span, and give signals if there is any difference of level between east and west trusses. The difference was corrected by regulating the rate or range of strokes in manoeuvering the jacks. A system of grillages, varying from standard rails to 750 mm. I beams, was used to support the jacks during the lifting or carry the weight of bridge when jacks are entirely removed.

The question of temperature effect was also under serious consideration. Record shows that the anchor span will expand or contract at rate of 1.5 mm. per degree C. The range of temperature for which the bridge was designed is from 30°C to 50°C with 10°C as normal. The total movement of bridge will, therefore, be 120 mm. from extreme cool to extreme hot weather. This will certainly exert a tremendous amount of strain to the temporary timber frames, although such worst case is seldom if ever happened. It seems that some sort of expansion bearings must be provided at the tops of main supports. As mentioned in previous pages, the various units of original roller castings, which carry the anchor span, were all blown off the pier and scattered in all directions. Those odd ends were collected from the River bed and reshaped in the Railway Shop, forming an excellent expansion bearing.

The lifting of damaged simple span proved to be much easier as it was lighter than the anchor span. However, there was a vertical twist with horizontal shift to overcome. The former was gradually levelled by giving two strokes on west side and allowing only one on east during jacking. The latter was corrected by working a pair of 100 ton jacks placed horizontally against the fixed pedestals of the adjacent span.

The whole work was carried out entirely with Railway construction equipments, materials and labor at an estimated cost of $58,600.00. It is possible that the cost may be reduced greatly if salvages values of timbers and sleepers are taken into consideration. This temporary repair was completed in 34 days from December 17, 1928, to January 19, 1929. The structure was opened to traffic on the following day and found to be quite satisfactory with negligible settlement.

The order for 60 tons of new structural steel parts @ G.$131.50 per ton and 10 tons of cast steel @G.$171.50 per ton was placed recently with the original manufacturer in Germany. The permanent repair was pending until the arrival of new parts. It is believed that it will be finished before the end of June, 1929.



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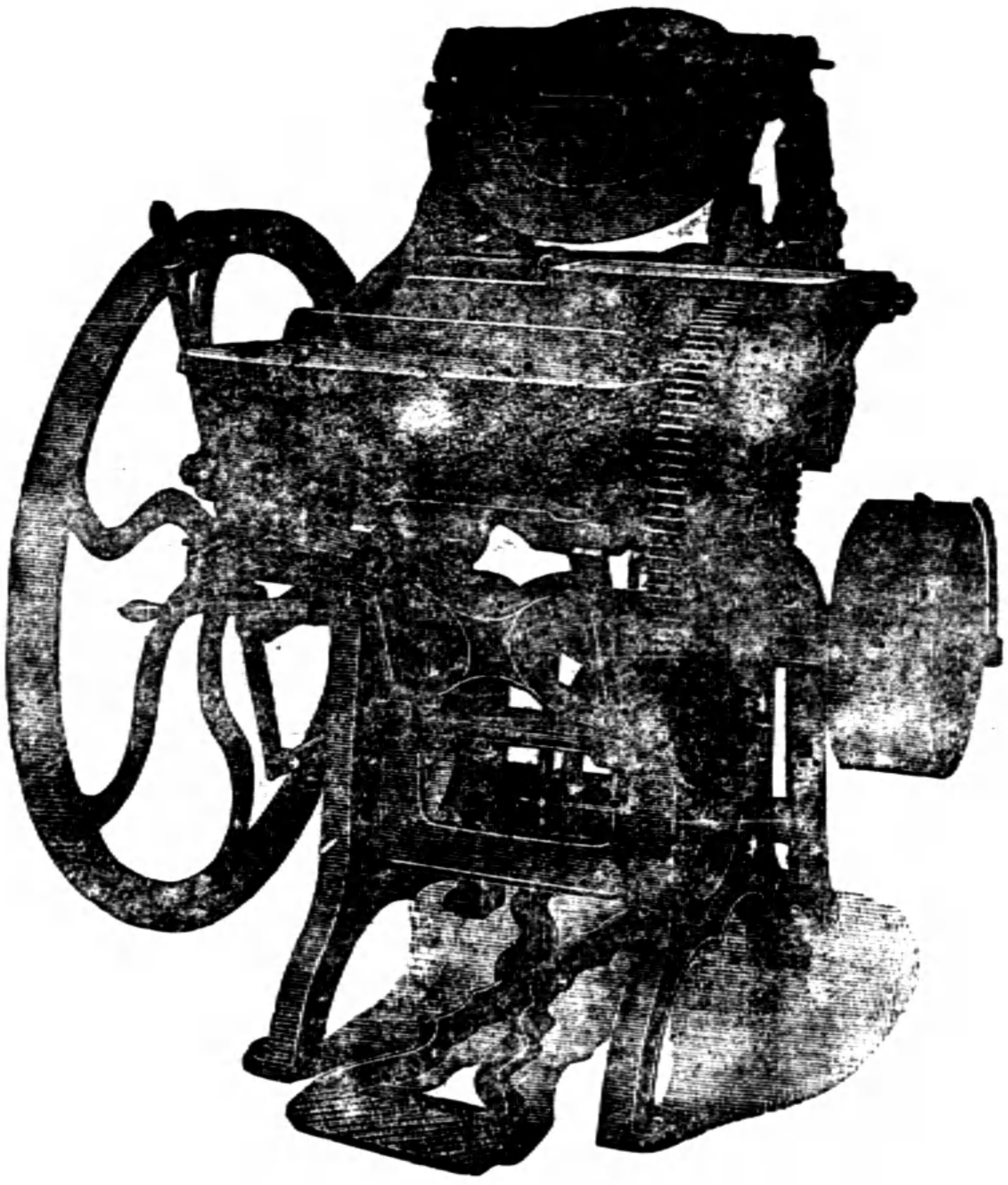

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建築首都中正街自流井之經過

著者：徐百揆

南京自定爲國都後.人口驟增.飲料問題.急待解決.自來水之創辦實刻不容緩.唯費用浩大.一時籌措不易.京市工務局.爲治本計.仍積極籌劃大規模之自來水.爲治標計.特在城內中正街,夫子廟,鼓樓街,科巷,北門橋,甘雨巷等繁盛之區.先行各開鑿自流井一座.以利市民.現在中正街自流井.業已全部竣工.其餘各井.正擬賡續進行.著者於一切工程之經過.均親爲主持.爰爲文述之.以供關心飲料者之參攷.尚望海內外同志.加以指正焉.

(一) 工程之內容　南京地瞵高山.城內各區.自地面鑿下百尺.卽見石層.而地質狀況.更素無詳細之查攷.故開鑿深水井.失敗者多.此次中正街所鑿之井.深度竟達至三百六十尺.實爲首道深自流井之嚆矢.其工程內容.可分爲下列各種.

(1) 鑿井　井爲四寸徑白鐵管.深三百六十尺.直達第三層水.開鑿時.用二匹馬力發動機.將鋼管旋轉鑽鑿.計自地面下鑿.每日平均可鑿八尺.至一百一十三尺時.過碎石英岩.則以旋轉速度不易勻配.旋轉旋停.未便再用機力.遂改用鋼杵.以人力擊鑿.每日只能開鑿三四寸.此層石質進行.最爲困難.幸至一一七尺.卽過砂岩.仍恢復機力.平均每日可鑿四尺.至二百八十尺時.卽發現水源.繼續鑿至三百六十尺爲止.該井計自開工日起.至鑿成日止.連雨天在內.爲時共三閱月半.

(2) 抽水機　裝置四寸半對徑.五寸來回.冷氣抽水機一只.每分鐘速度五百轉.一寸半冷氣小管.直插入井中.至一百八十尺爲止.冷氣受壓.吹動井水.沿冷氣管與四寸鐵管空間湧上井口.再由二寸半鐵管.導入水塔.爲抽水繼續連接及避免井水油光起見.特另裝置冷氣箱.

第一圖 首都中正街自流井工程進行時之狀況

(3)發動機 係用立式柴油發動機.七匹馬力.每分鐘速度五百五十轉.每小時用柴油三磅.

(4)蓄水塔 十七英尺對徑.十五英尺高,能容水二萬五千加侖.周圍以鋼板配製.柱子用工字鐵.底脚以水泥混凝土建築.

(5)機器房 長十四英尺.寬十二英尺.係爲放置抽水機發動機及冷氣箱之用.

(二)工程價目

(1)	鑿井	$ 4,155.12
(2)	抽水機及冷氣箱	734.07
(3)	發動機	1,315.78
(4)	蓄水塔	5,193.90
(5)	機器房	554.03
以上五項工程共計		$1,1952.90

(三)完工日期 鑿井共計三月半.裝置機器水塔及建築機器房計一月半.

(四)水量 該井原擬達到每小時三千四百加侖爲標準.現經試驗結果.以地層水源不旺.每小時出水量爲一千一百加侖,以後繼續抽水,則含水沙岩層.亦必逐漸鬆動.而水量自可增加矣.

(五)水質之檢驗 檢驗井水之水樣,係取自水龍頭.其取法先將水龍頭

開放五分鐘.然後灌入玻璃瓶.經檢驗結果.該水堪作飲料之用.

(甲)物理的　無色無臭盛玻璃瓶對光照之不現渾濁.

(乙)化學的　以百萬分之幾計算或一立脫(Liter)容量內米立格蘭姆(Milligram)之數.

未化合磷精之淡氣	Free Ammonia	0.380
蛋白磷精之淡氣	Allumenoid Ammonia	0.180
綠化物之綠氣	Chlorine of Chlorides	127.50
亞硝酸鹽之淡氣	Nas nitrites	0.00
硝酸鹽之淡氣	Nas nitrates	0.104
養氣之消耗	Required oxygen	1.456
渣滓之總量	Total Residue	700.00
有機及揮發物	Organic and Volatile matter	360.00
暫時硬度	Temporary Hardness CaetcCo$_3$	446.00
永久硬度	Permanent Hardness Caetc So$_4$	0.00

以上係中央大學化學分析之報告

(丙)亞菌的　在攝氏卅七度培養四十八小時後每千立方公分水細菌數爲一二〇〇

在攝氏二十二度培養七十二小時後每千立方公分水細菌數爲五〇〇.〇〇〇

B. Colic及Glucose fermenting organisms在四十立分公分水概不發現至五〇立分公分始行發現

總之此井水之細菌在人體温度時並不多.有害菌之數目亦至爲有限.故該水堪作飲料之用.

此井水在低温度時,雖可發現細菌甚多,但大多數均無碍衛生.如作飲料.先當煮沸爲佳.

第二圖　地層剖面圖

以上係上海化驗室之報告

（六）地質之查考　此井開鑿時每層地質均詳加紀錄.且採取標本存貯玻璃匣.以供參考.其逐層地質列表如下.並見地層剖面圖.

地層之深度	地層名稱
自地面起14英尺	含白雲母之細砂 (Fine sand with muscovite)
„ 14—29 „	含各種礦物之砂礫 (Sand with different minerals)
„ 29—105 „	較上純粹之砂礫 (Sand much purer than above)
„ 105—110 „	較粗砂礫 (Sand coarser)
„ 110—113 „	燧石質砂礫 (Cherty sand)
„ 113—115 „	含碎石英岩之砂礫 (Sand with broken quartzite)
„ 115—117 „	石英岩 Quartzite
„ 117—360 „	砂　岩 (Sand stone)

制馭黃河論

著者：恩格司　譯者：鄭肇經

(一) 黃河之現狀

黃壤之性質,一黃壤散布之區域,一黃河上游峻岸之由來,一下游地層及兩岸沃土之成立,一隄防之緣起,一隄防崩潰及河道改變之原因,一一八五二年北岸決口黃河改道,一一八六八與一八八七年南岸兩次大決口,一上下游水坡之比較,一流量之推測,一下游不利航運之原因,一挾砂量之可驚,一隄防位置之考察,一河床高出兩岸之尺度,一河床增高之原因,一計算流速之公式,可應用於黃河,一固有隄防之構造,一中國河防工程之技能.

黃河上游六十萬方公里之高原,皆爲『黃壤』所覆蓋.黃壤雖具相當之凝結力,而頗易爲流水所冲刷,粗視之似爲『粘土』之一種,實則大異;蓋粘土之成因,或因風雨之侵蝕,或爲冰河時代沈澱於低地之土質,而黃壤則否.但黃壤既具土性及黃褐色,謂之似粘土,亦無不可.黃壤與粘土性質上之最大區別,爲黃壤性疏而易於滲漉,吸水之量絕類海綿,且不現濘泥之狀;而最奇特者,黃壤性易直裂壁立如削,形同危崖而無斜坡.考此特性之由來,乃黃壤成分中包含無量數之直立微細管,微細管外裹石灰質;石灰質則爲古代含石灰之植物莖根所遺留,以黃壤之下,恆發現僅具極小滲漉性之泥灰石層也.黃壤之分子細微如沙,又極輕鬆,揉之立成薺粉,故可隨風飛揚.惟道路上之黃壤,設遇天雨,久經車馬踐磨,即失去滲漉之性,成爲眞正之粘土矣.又黃壤爲最肥沃之農壤,當田禾生長時期,苟得充分之雨量,不需肥料,可以滋長.

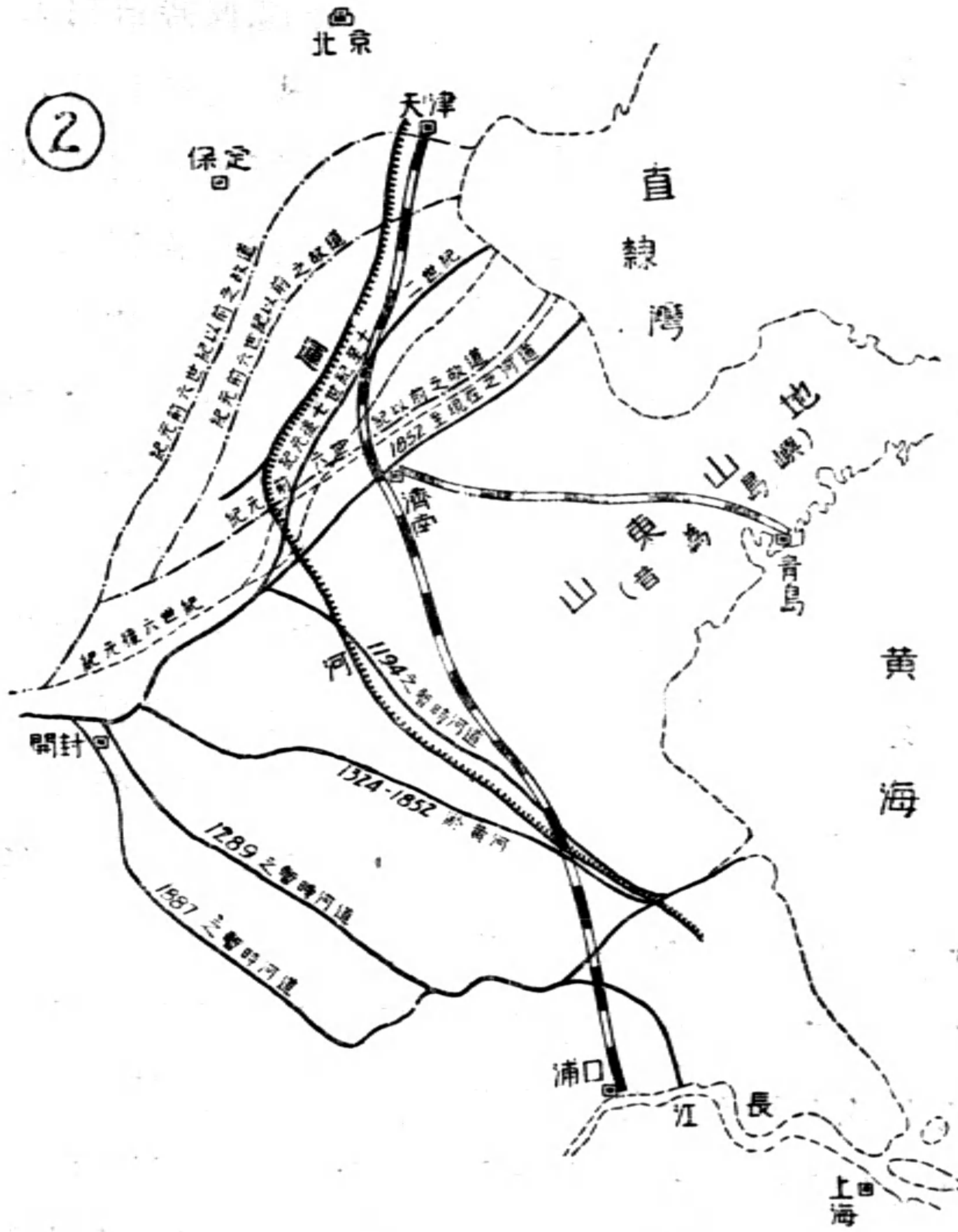
中國北部黃壤區域頗爲遼闊.(第一圖) 黃壤之播散,與地形絲毫無關,除高聳之峰巒外,高山低谷,均被蓋同樣之黃壤.層積之厚,恆爲數百公尺.由此推知黃壤實爲風伯之騃子,徵風伯之力,不足以使之均勻散布於陵谷.據地質家之考察,黃壤區內,因未能發現由數千年耕種而成之沃土層,足以證明

黃壤尙日增無已.但黃壤之眞正成立時期確已過去,因古代氣候變遷後,洪水橫流之荒原,已變爲泄水入海之沃壤也.

黃壤既具極大之滲漉性,雨水固無停積之機會,亦不能暢流於黃壤之上部.小部分之雨水僅集於淺渠而下滲,大部分之雨水滲入黃壤層,匯於地面下之堅固石層,或不透水之泥灰石層上,循坡度下流,是爲地下水流,或稱爲『潛流』.潛流恆冲刷輕鬆之土層.以闢流徑,匯入地上河流.地上河流再匯合衆流,朝宗於海,此自然之公例也.而潛流流於易侵蝕之黃壤層內,闢徑而外,同時可擴充流渠,漸成穹形.日積月累,黃壤勢必崩坍而罅穴益廣.迨上層穹狀之黃壤盡坍,兩旁之黃壤仍壁立對峙,於是潛流乃成爲地上河流;故黃河上游之支流,多發現於數百公尺高之黃壤削壁間.墜入水流之黃壤塊,則推轉下移,漸混水中,呈現黃色.舊河卽爲匯合黃壤區內各支流朝宗於海者也.

考查黃河下游之山東山地,與中國其他山地,中隔平原(第一圖);平原之成因,則爲沈澱物所冲積;沈澱物之上層,卽黃河所攜挾之黃壤.冲積之時機,應爲黃河泛濫,洪水橫流之期,所謂黃河之『洪積層』是也.而黃河於洪水期內溢出河槽,泛濫於兩側平原之時,河槽之水流行較速,泛濫區內之水流行較緩.笨重石礫恆下沈於二者之間;細微之沈澱物則多淤積於泛濫區內,是爲『沃土』.惟大部份之沈澱物仍隨河流注入於海,故黃河恆呈現黃色也.黃河既挾沙過量,河牀淤積,漸高出兩岸之平原,勢必泛濫而改道.經屢次之改道,乃成一極偉大極平坦之『冲積洲』.冲積洲上所發現之長段砂質,蓋卽數千年來黃河之故道也.

黃河兩岸既爲沃土,甚易引誘農民從事墾植.墾植之先,必防範水流溢出河槽,使不爲患,此乃兩岸隄防成立之緣起也.但隄成以後,沈澱物既無從發洩,又不能盡量同注入海.於是河床增高較前更速,而兩隄間河身彎曲過甚之處,又每於洪水期內冲刷益烈.河身日近堤岸,則堤岸之崩坍堪虞,卽搶護得力,堤岸能支持於一時,然侵蝕既久,終必潰坍,而黃河全量之水,乃復溢出

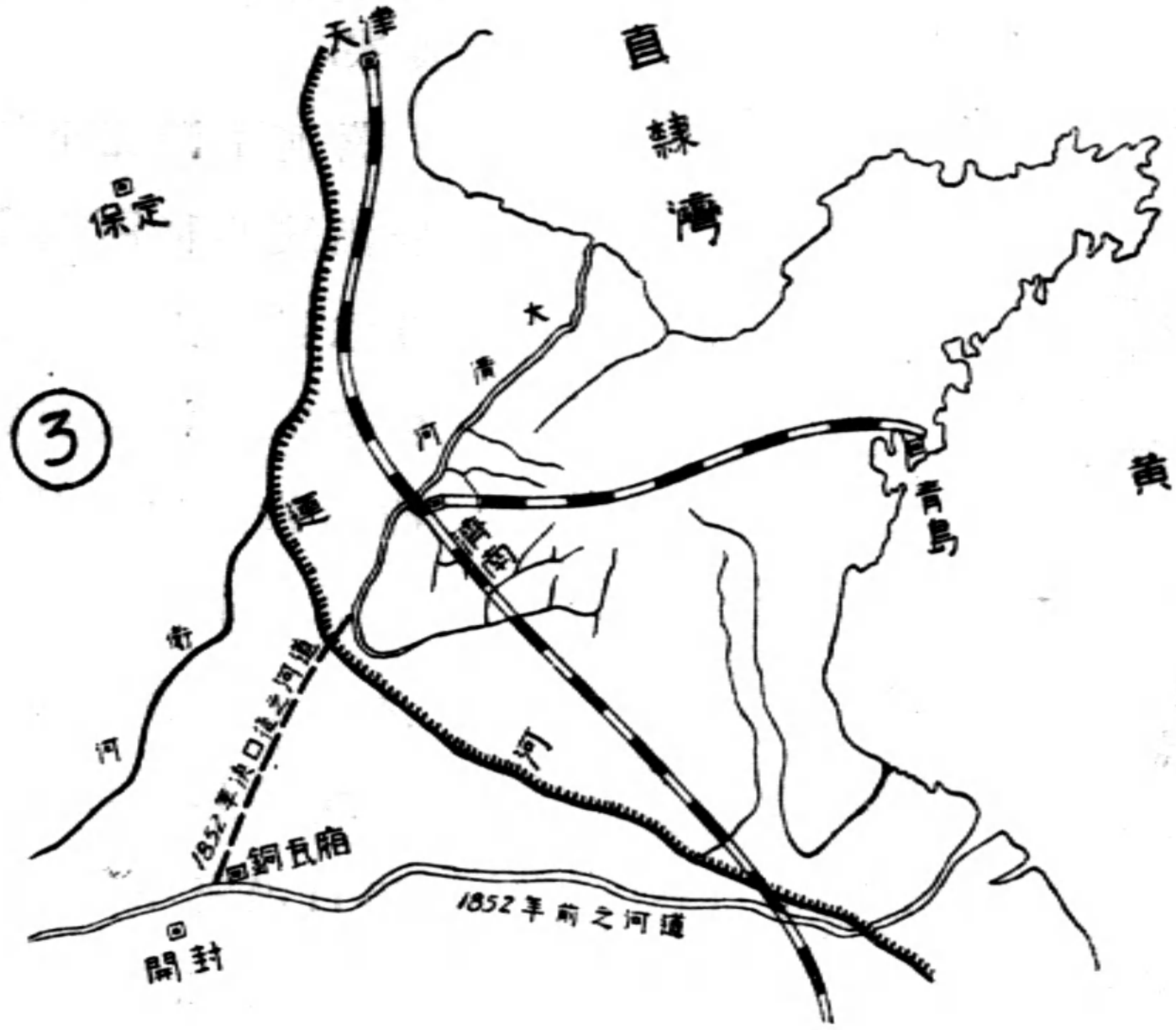


②

河床,奔騰泛濫於平原矣.

黃河下游完全流於錐狀冲積洲之『分水嶺』上.隄防兩側之天然河流恒循冲積錐之坡度,星芒四射而下流.而黃河之河床淤積,又往往高出隄外之地;加以河口淤塞不暢,勢必逆行橫流.迨乎隄防既潰,水不歸槽,河道乃遷.是故黃河兩岸人民以土地肥沃而墾殖於斯地者,累世被其害矣.

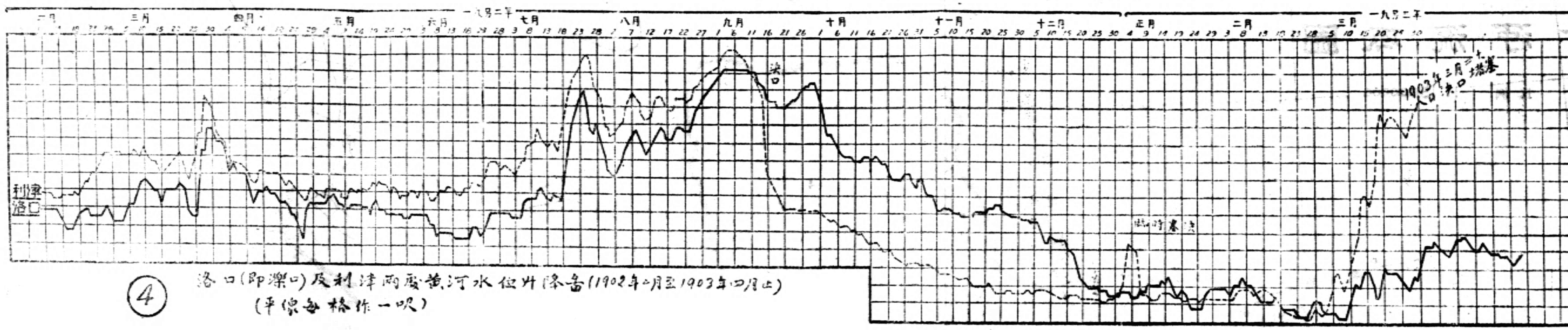
數千年來黃河決口改道,數見不鮮(第二圖),而最近六七十年內之決口改道,尤與日後治河有莫大之關係焉(第三圖).先是一八五一年秋汛,開封府以下之北堤決口.翌年決口擴大.一八五三年黃河全部水量注入新河道,向東北而流,橫貫運河,再三十公里與大清河合,由利津入海.案黃河舊河道已歷六世紀半之久,一旦委棄故道,遷徙五百餘公里長之下游河身,從利津入海,新舊二河口竟相距四百五十餘公里之遙,實爲世界所罕見之事也.自此而後,黃河又曾兩度試驗改道,且均在東經 114°5', 沿冲積洲平原之南隄.一八六八年洪水爲災,該處之堤防崩潰.翌年又遭洪水,遂致廣大平原再經



泛濫.彼時治河人士志趣分歧,或以爲河仍北流,或以爲河將南遷.卒從前說,不惜糜費,堵塞決口,迄一八七○年二月工程告竣.一八八七年春南岸又決口,與修堵之口甚近(經度 114.°)受災之區益爲擴大,重災之區約二萬方公里,輕災之區約三萬方公里,淹沒村莊以數千計,溺斃居民以數十萬計,竭朝野之力,至一八八九年正月復將堤防修竣,導黃河仍入一八五三年所改之道.一八九八年濟南府下二十八公里再決口,被災之區約三百方公里.最近據費禮門(John R. Freeman)之報告(十)又決口二次:一爲一九一九年七月之決口,三百二十五方公里之沃土盡成澤國,五百六十餘村落飄沒爲墟,二十一萬七千餘居民流離失所;一:爲一九二一年夏下游之決口,損失亦屬不貲,且有數公里之河道改徙,誠浩劫也.

黃河紀載之豐富,爲世界各河流冠(六),然未加整理,散佚迨半,故數千百年黃河之詳史,無可攷查.最近又未應用新法,實測全河情形,故我等對於黃河之知識,仍屬極不完備.黃河之長,估計爲四千公里;上游計一千六百公里,中游計一千八百公里,下游計六百公里.上游多爲崇山峻嶺,故水面坡度頗不一致,平均約爲0.00175 河寬約在三十公尺以外.上游絕對不能駛船.注入黃河之水,雨水較融雪之水爲多.中游之寬,隨兩旁壁立之黃壤岸而變更,水


①黃河流域圖
比例 1:15,000,000
陰山山脈
黃土地域
賀蘭山
西傾山
積石山
岷山
秦嶺山脈
太行山脈
汾水
渭水
巴顏喀喇山
北京
天津
大沽
蘭州
潼關
陝州
洛陽
鄭州
開封
大名
濟南
泰山
新黃河口(1889)
舊黃河口(1852)
渤海
黃海
東海
遼東
黃土地域
上海
洪澤湖
揚子江
金沙江



④ 洛口(即濼口)及利津兩處黄河水位升降圖(1902年二月至1903年四月止)
(平線每格作一呎)

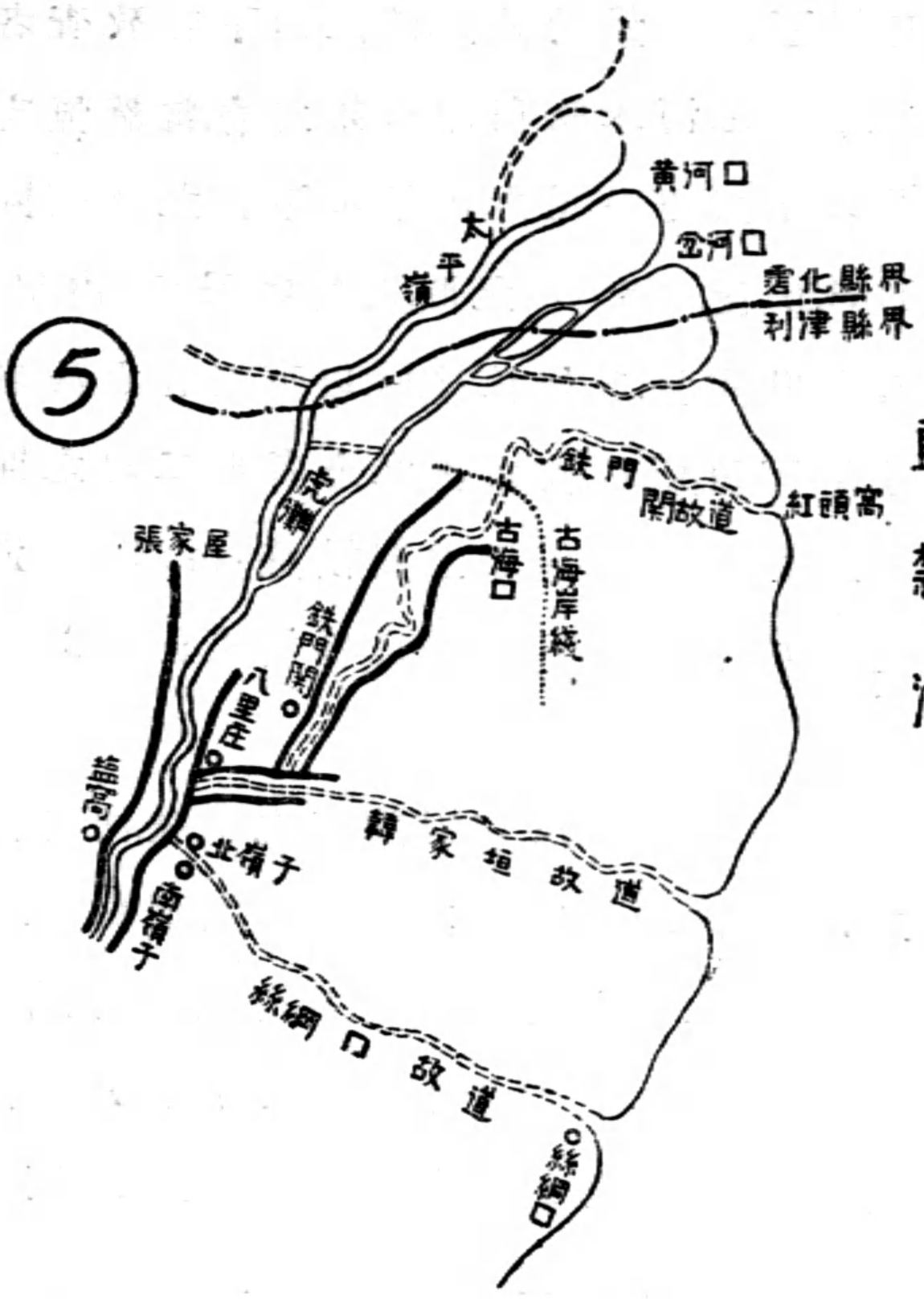
⑦ 濟南至利津黄河形勢圖

面坡度平均爲0.00082.數段可通舟楫.下游則始於孟津,從此而下宜攷查者,爲黃河流入平原處,爲下流改道處.下游之河床既在冲積錐之脊,當然無支流來滙,故下游全部水量,卽爲上游六十萬方公里之雨量也.下游之寬,隨隄防之距離而異.山東境內自東經116°20′至118°50′之間,堤爲雙層,曰『內堤』『外堤』.內堤又名『縷堤』,逼近河身,勢甚卑矮,形如絲縷,所以束湍悍之流者也.外堤又名『遙堤』,在縷堤之外,遠離河流,所以備衝決之患者也.二堤之間,或有村鎭,更自圍築堤防,以資保護.又或於縷堤遙堤之間橫築『格堤』數道,縱使決口泛濫,僅限一格之內.內堤終於東經118°29′雙堤終於東經118°23′自此以下則內外二堤相併矣.

河南境內雙堤僅發現於城鎭所在地.水面坡度則因隄防之廣狹,河身之彎曲,與河流之分岔而異,平均爲0.0002較之上游之水面坡度,實屬微小.

凡計算『流量』之公式,莫不以流域內之雨量爲準鵠.但黃河流域每歲之平均雨量,及附近各地雨量之比較,尙付缺如,故我等不能採取任何已有之流量公式,應用於黃河.試於黃河下游,曾用機械測得數處之流量;洪水期內最大之流量約爲每秒鐘八千立方公尺,低水期內之最小流量約每秒鐘三百八十立方公尺.洪水期恒在每年之七八月間,低水期則在十一月至翌年五月之間.其水位之差異,洪水之變遷,均極劇烈(第四圖).

黃河下游自河口上溯五十公里以內,爲與海潮接觸之處,亦卽爲『三角洲』成立之所(第五圖)三角洲之外,有極廣之沙灘,橫亘於前.沙灘之上祇有少數較狹之流槽,於低水期內水深約爲二公尺,其餘之流槽,水深不過半公尺許.自運河至黃河口之間,舟楫交通雖頗隆盛,但最大之船載重量亦不過一百十噸左右.就河口情形論,實無法開闢航道上溯至數百公里之道.因沙灘外之海潮高度可達二公尺半,而沙灘以內之潮水高不及半公尺.且海口於一八八九年在鐵門關以北四五公里又向東分一支流入海,其長度約爲二十公里,分去主流水量甚多(第一,及五圖)彼時山東當局曾擬於新分



支流兩旁築堤作爲通航之河口云(二).

考查黃河之水量,及洪水期與低水期每秒鐘流量之差異,絕無奇特之處.且水量對於流域面積之比較,反覺微小.所堪注意者,惟混雜水流中之沈澱物耳.全世界各大河流中,攜挾沈澱物若黃河之多者,苦無例足以比擬.尤堪注意者,上中游之河道,多流於黃壤削壁之間.洪水期內,嚙蝕特甚.據一八八九年荷蘭工程師單百克及魏舍(P. G. Van Schermbeck, U. A. Visser)關於一八五二年決口處以上一段之報告(三):『余等曾沿黃河之北岸從事視察,河岸壁立,約高出其面一公尺.在余等航行半小時以內,平均每十秒鐘必見河岸上之黃壤爲水所冲刷,巨塊下墜,砰然有聲.黃壤入水後之移動,初則甚緩;水淺處則停而不動,旋即分散於河灘上,故該處積沙極多.而河水冲擊河岸,激而上升,往往達六·五公尺之高云』.又據單氏等實地之試驗,可知黃河各段每一立方公尺所含沈澱物之重量如次:

	時期	地段	每一立方公尺水所含泥砂重量
1	一八八九年四月二十六日	汜水河(經度113°20°)靠岸之水,在水面下一公尺七五河床以上半公尺	3708 格蘭姆
2	一八八九年五月三日	一八五二年決口處(經度114°40°)河心之水,在水面下一公尺七五	4491 格蘭姆

3	一八八九年五月廿一日	齊河(經度116°)河心水面上之水		5620 格蘭姆

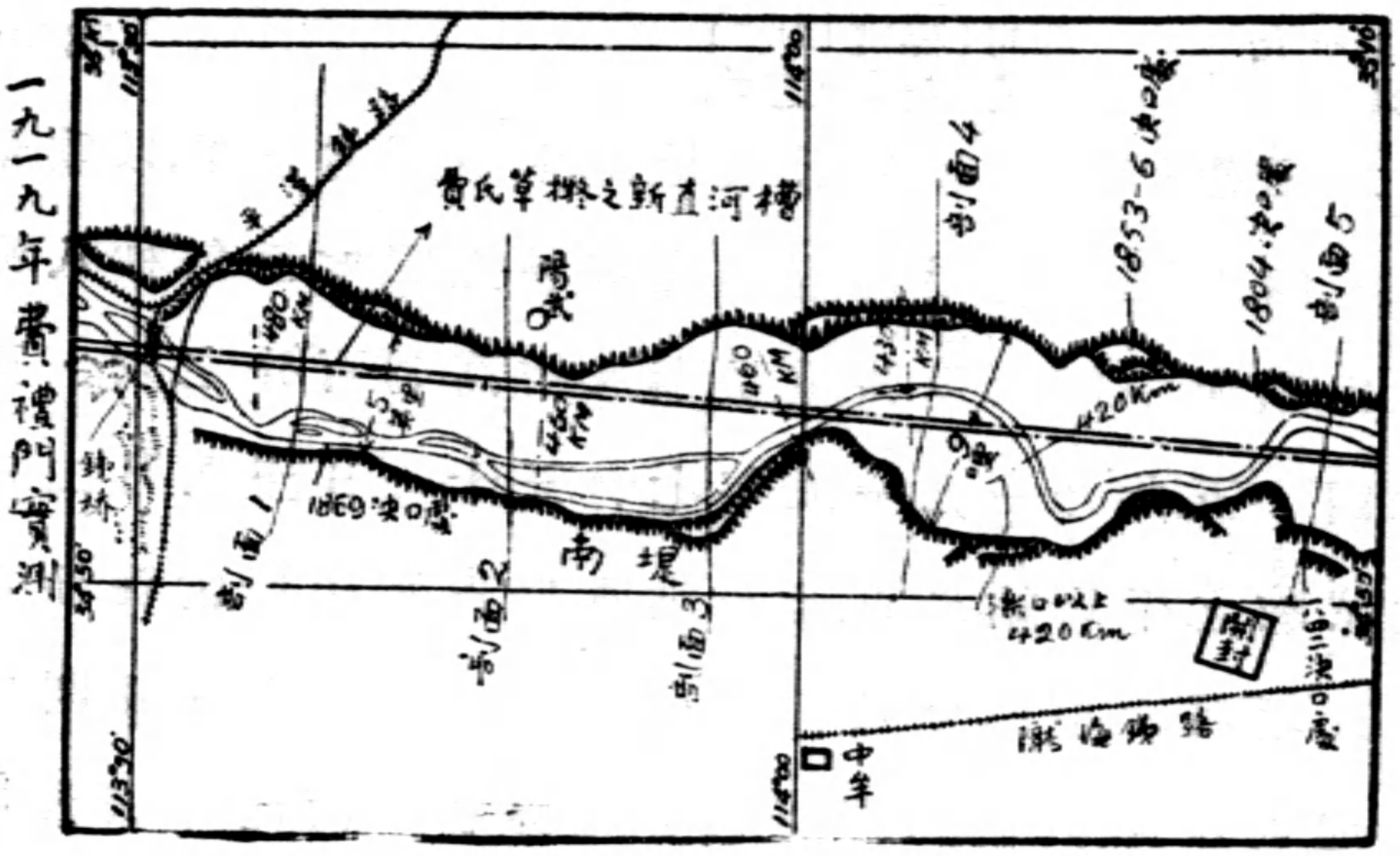
又據費禮門之紀載(十):『尋常低水位時,水中所含沙量,以重量計平均約爲百分之〇・四.設河流之平均速率從每秒五呎增至每秒八呎,在一星期至三星期之內,則河中所含泥沙重量,漸次增高爲百分之六・五.設以體積計,爲百分之四・五.此乃一九一九年七月三十一日至九月二日在六處地方經十八次試驗之平均結果也.若在洪水期內,水中所含泥沙重約爲百分之九或十.而此項泥沙,小部分乃當地被冲刷之土,而大部分則爲從上游土質輕鬆之山地攜挾而來也』.茲更列舉世界各大河流之挾沙量,以資比較;則黃河挾沙量之豐富,可見一斑.

河名			挾砂量	
非洲尼羅河	(洪水期)		1580	格蘭姆/立方公尺
印度恆河	(洪水期)		1940	,,
北美密西西比河	(平均)		670	,,
歐洲多惱河下游	最大量		2151	,,
	最小量		354	,,
歐洲萊因河下游	在荷蘭 Panenden 地方	最大量	310.5	,,
		最小量	2.5	,,
,,	在 Gorinchen 地方	最大量	1174	,,
		最小量	10	,,

由此觀之,黃河口之海岸,每年約漲出三十公尺,與兩岸平原上黃壤層積之厚,莫非攜挾極大砂量造成之果.而河身爲隄防所限,河床日益增高,亦屬自然之理也.

吾人欲知黃河河床爲何而增高,不得不先研究隄防之布置.茲據費禮門之報告(十)(第六圖):『黃河下游於黃運交叉處以上,兩岸內堤之距離,自六公里至十三公里不等.黃運交叉處附近,及以下三十公里,內堤距離僅一公里半,再下一百十三公里,在津浦鐵路濼口鐵橋附近,內堤之距離,約僅二公里至三公里.(第七,及九圖)』又據一九一九年測得之黃河橫剖面,可規定河床與高度與隄外平原之比較(第七,九及十圖)在三義寨地方(即一

⑥



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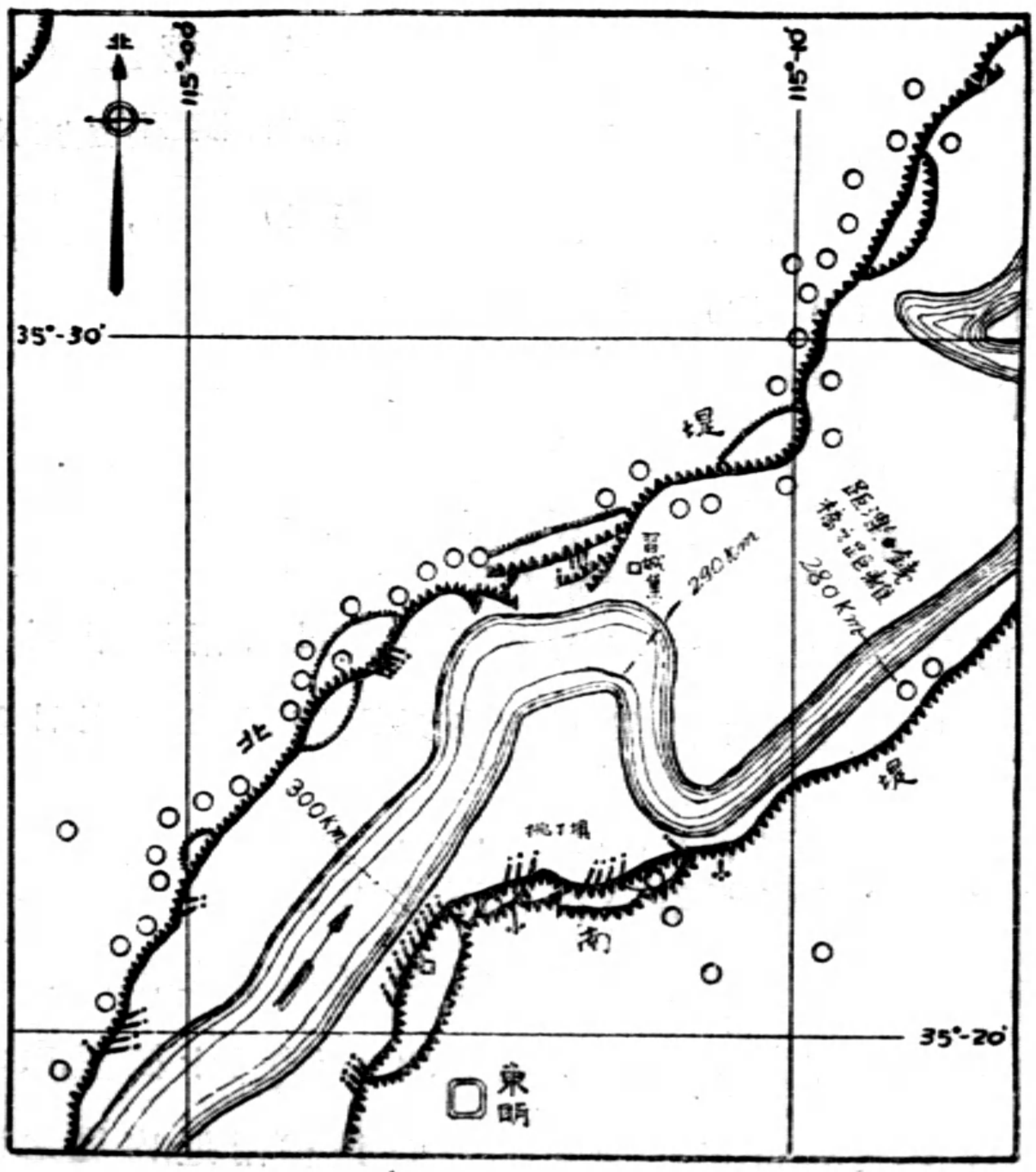
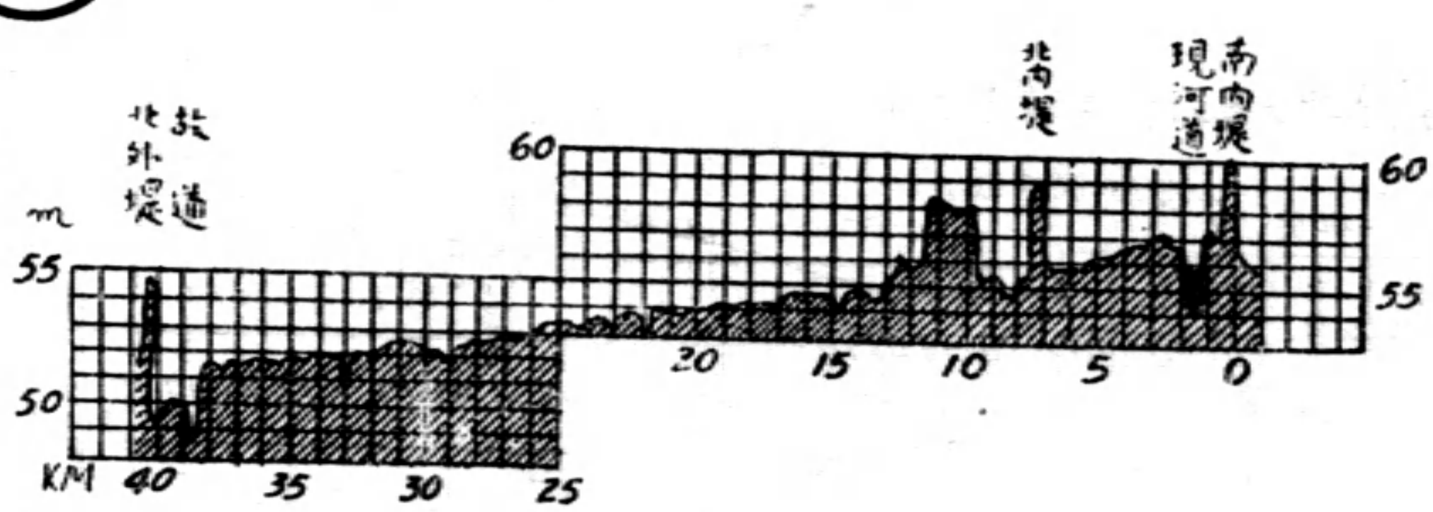


八五一年決口處以上八公里),之橫剖面,河床高出兩岸平原,頗爲顯明.自一八五一年決口處以下十三公里,四十五公里,及一百四十二公里三處,所測之橫剖面,河床已不高出兩岸外之平原.就橫剖面之計算,自京漢路鐵橋至一八五一年決口處一段,長一百三十公里,洪水期內水面高出兩岸平原約爲六公尺至七公尺半.低水期之水面,約高出一公尺半至三公尺.又算得低水期內河床平均高出內外隄間之地面約一公尺半.河床之

⑨

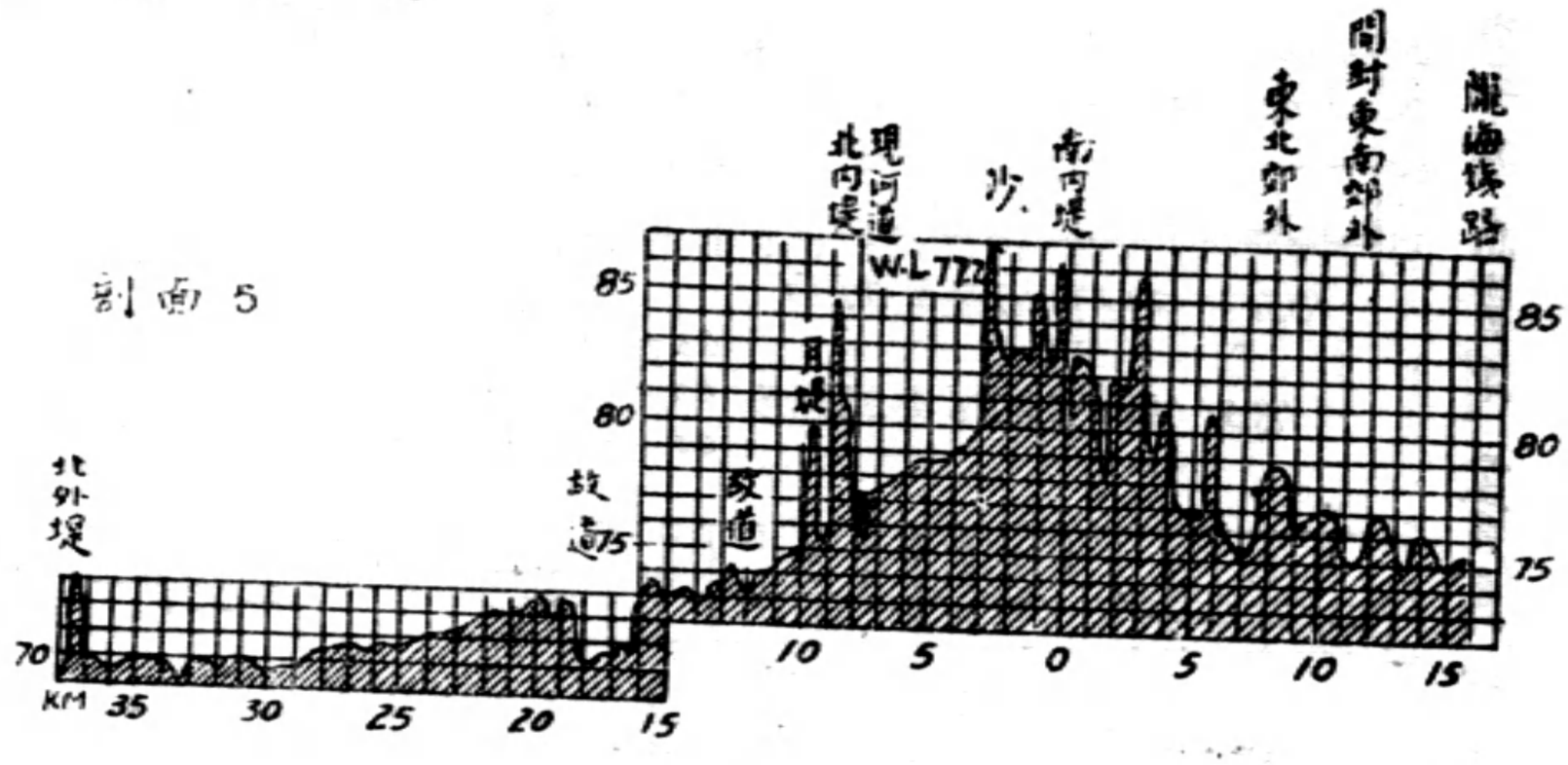
剖面7（1852決口以下54哩即87公里）



津浦鐵路濼口鐵橋以上

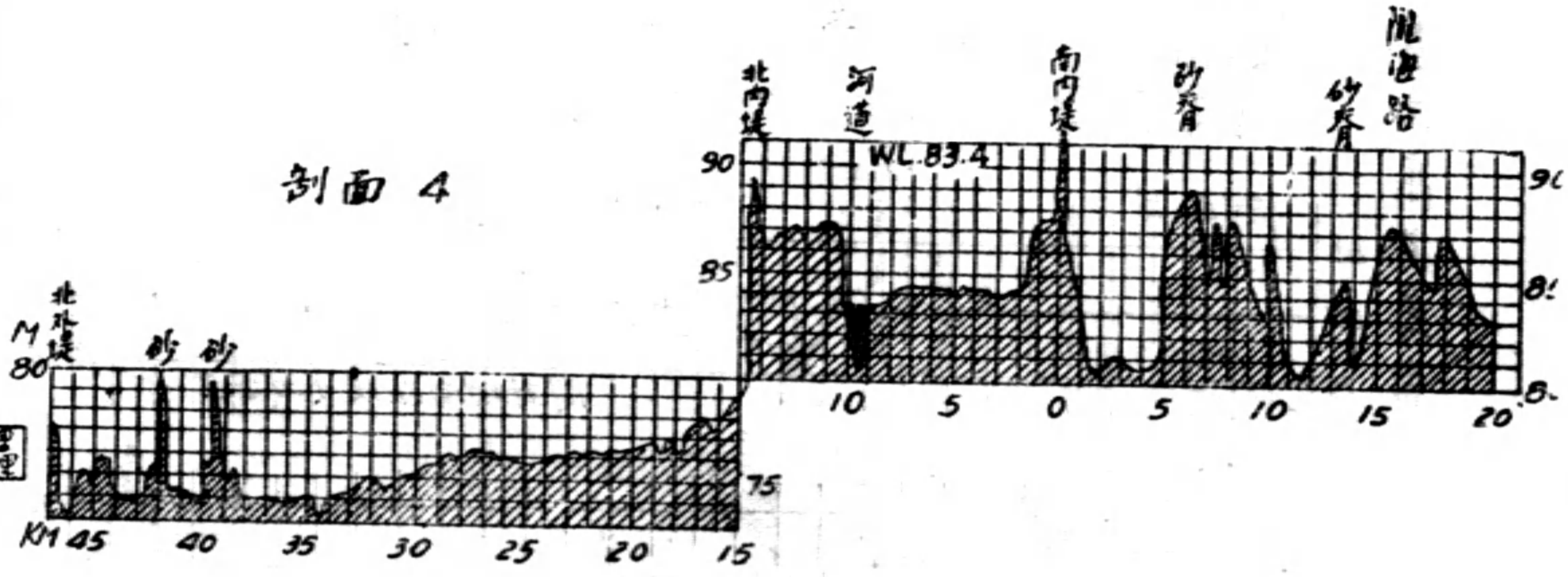
170哩 273公里

剖面5



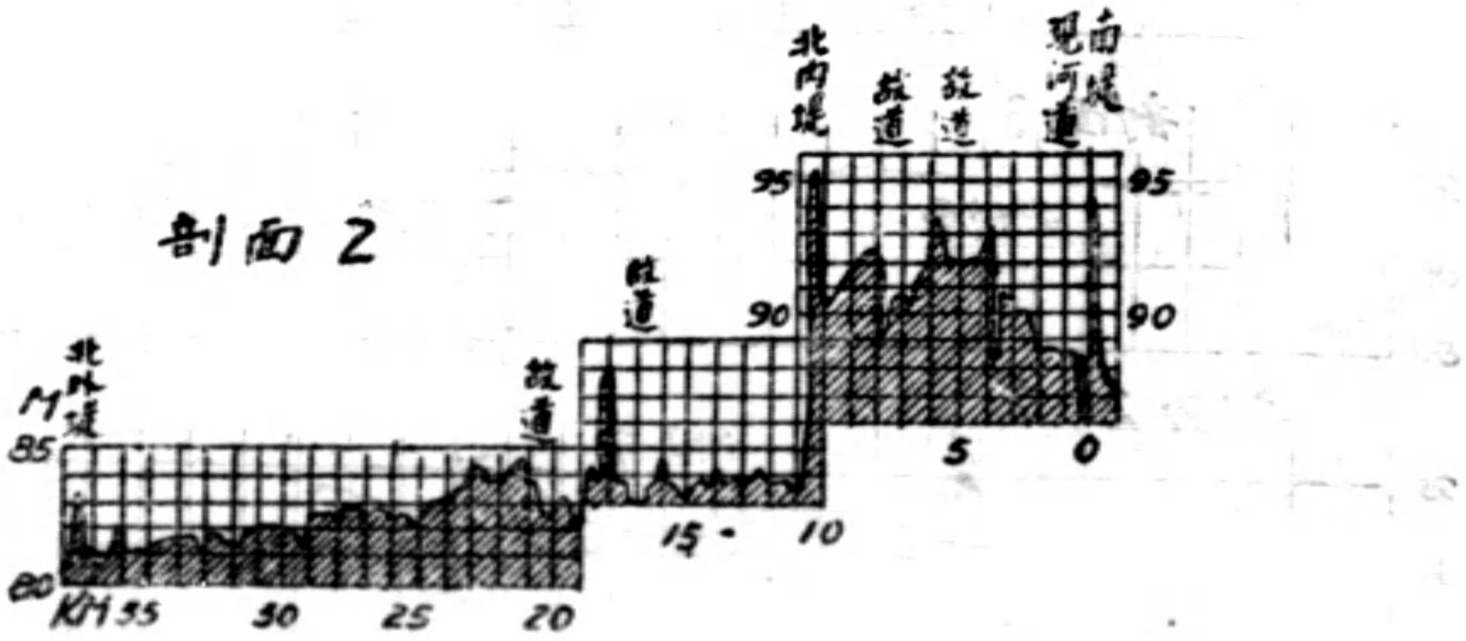
214哩 343公里

剖面4



267哩 429公里

剖面2



288哩 463公里

(10)

依據青島水平基点實測（青島水平基点高出黃海平均海面二・三公尺）

墊高,顯爲沈澱物之淤積;沈澱物之所以淤積,則因河口三角洲日漸向海中伸漲,遂致河道延長,水面坡度減小,排洩不暢,而沙質淤積矣.單氏與魏氏報告中曾有一八八七年決口區內之河床,高出堤外平原一公尺半之說,信不誣矣.

復次,堤成以後,砂土淤積之範圍,祇限於堤外之灘地.黃河下游堤外之灘地,甚爲遼闊.洪水期之水流,溢出河槽,泛濫於灘地,直流而下.低水期內水循槽流,蜿蜒屈曲於內堤之間.河槽既非鞏固,每遭洪水,河槽莫不改移,勢必彎曲益甚,而流道加長.當洪水驟落之際,水歸槽流,以流道忽長,水坡低落.抑轉力弱,平均速率亦減.於是水中之沈澱物,僅一部分之細微砂土順流而下,重大之砂質則停積於河槽及灘地之上,此河床高出兩岸外地面之又一原因.

總括之,得以下之結論曰,因堤防距離之遼闊,河岸之欠缺堅實,及河床經洪水後彎曲之劇烈,與易於分出支流,故水流之挾砂能力減小,而淤墊爲患矣.苟欲證實此結論之不謬,可觀察黃河流於山峽之一段,洪水低水均限於峽內流行,洪水之道不加寬,低水之道不紆曲,沈澱物暢流能無停滯之患.是以荷蘭工程師單魏二氏亦嘗建議(三),將距離過寬之隄改狹,以限制河身.且證明齊河(濼口以上數公里)地方,河寬僅五百四十公尺,水坡並無異乎尋常之處.而費禮門氏不僅在隄防過寬之弊害上注意,且已測得實例.證明隄防距距離狹後,雖洪水期之水量,仍可暢流,而水面坡度仍不加大.又以一九一九年在黃河運河交叉處以下三十一公里與二十一公里二地,測得之橫剖面(第十一及十二圖)詳細考察,知洪水下流時,河床雖易遷移,而水坡不變也.茲更就費氏測得之數代入『韓慕開』(Hermanek)之公式,而證明之.

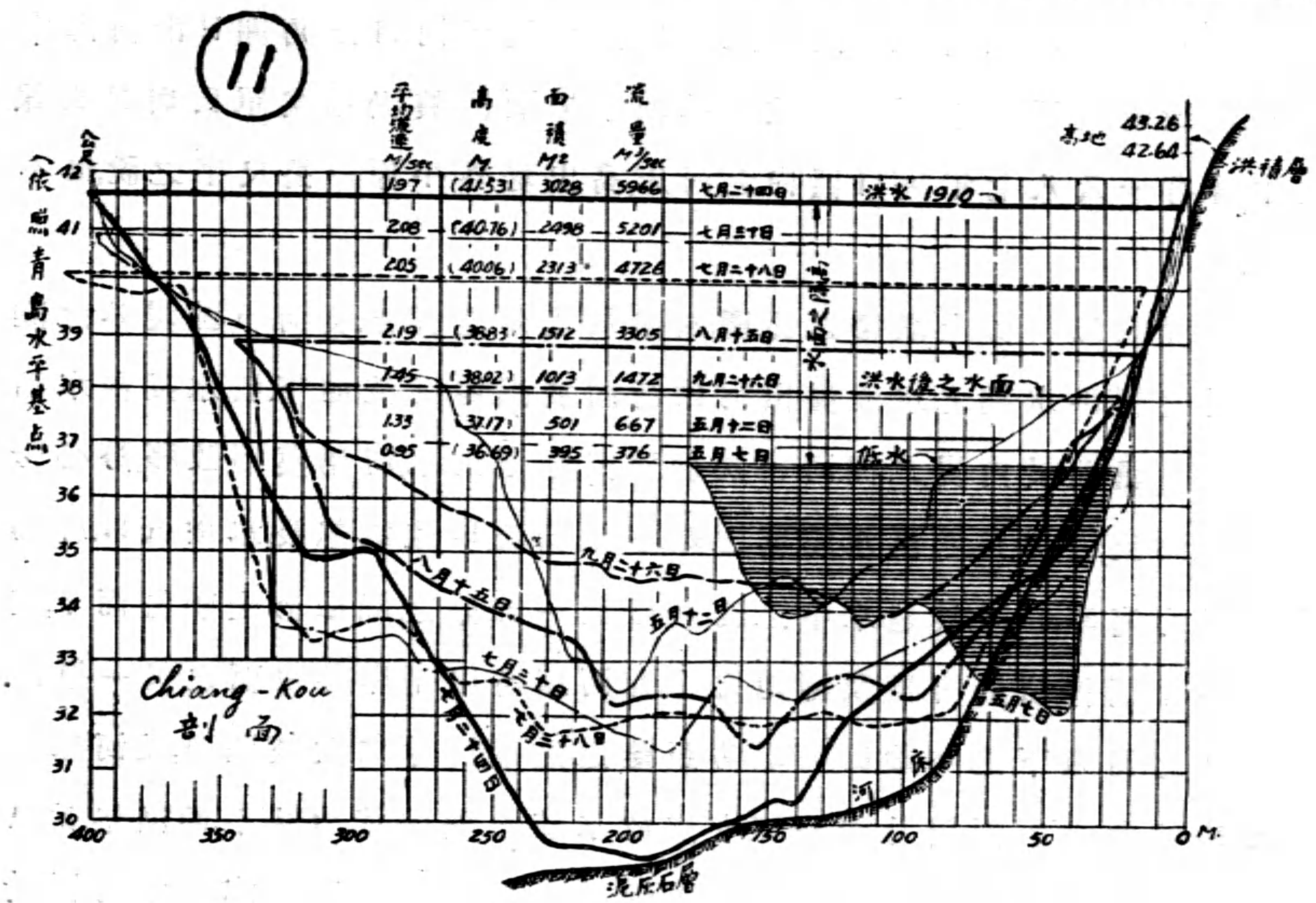
費氏測得之數(第十一圖)　　$V=C\sqrt{tJ}=\frac{F}{Q}$

流　量　$Q=5966\ m^3/sec.$;　　面　積　$F=3028\ m^2$

平均速率　$V=\frac{Q}{F}=1.97\ m/sec.$

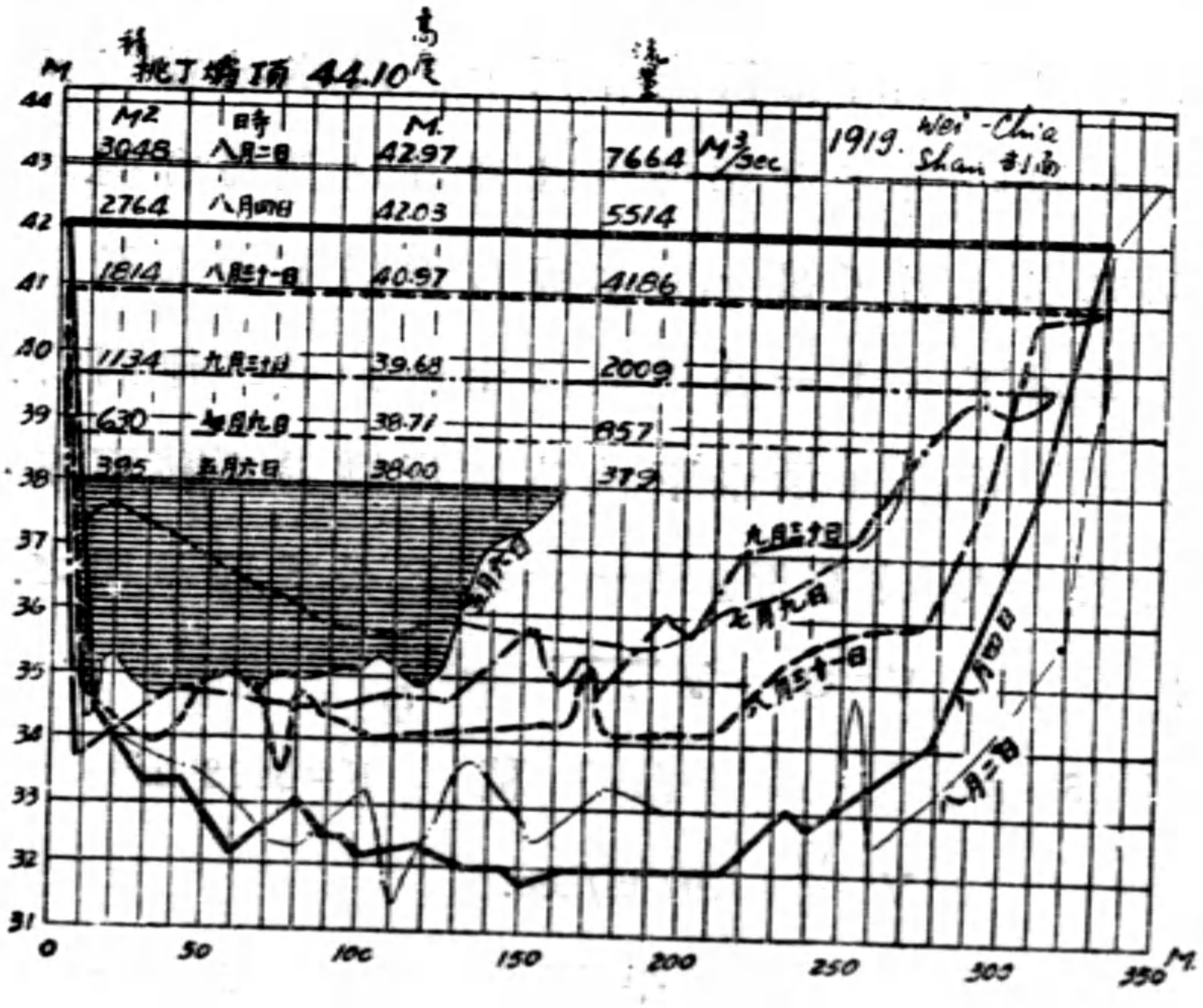
水面寬　$b=400\ m$　　平均深　$t=7.57\ m$

(11)



附註　測量時適逢洪水期水量較低水位時大十六倍速度大二倍

(12)



按韓氏係數表

係　數　$C = 54$

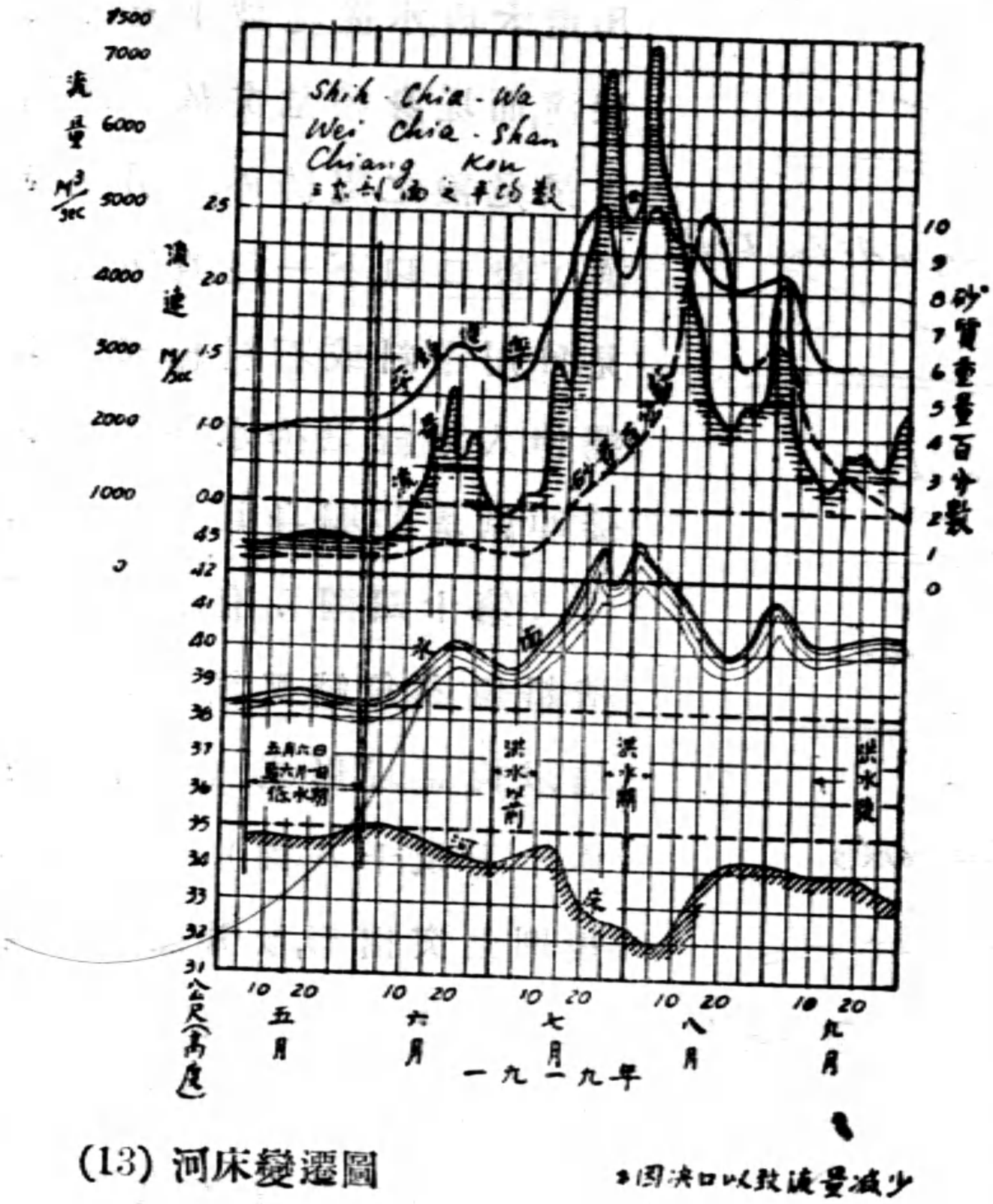
則　$V = 54\sqrt{7.57 \cdot J}$

$= 1.97$ m/sec

則水坡　$J = 0.000172$

此數與前所推測之平均水坡 0.0002 相差甚微. 是以黃河雖攜挾沙量過多,似仍可應用尋常計算流速之公式也.

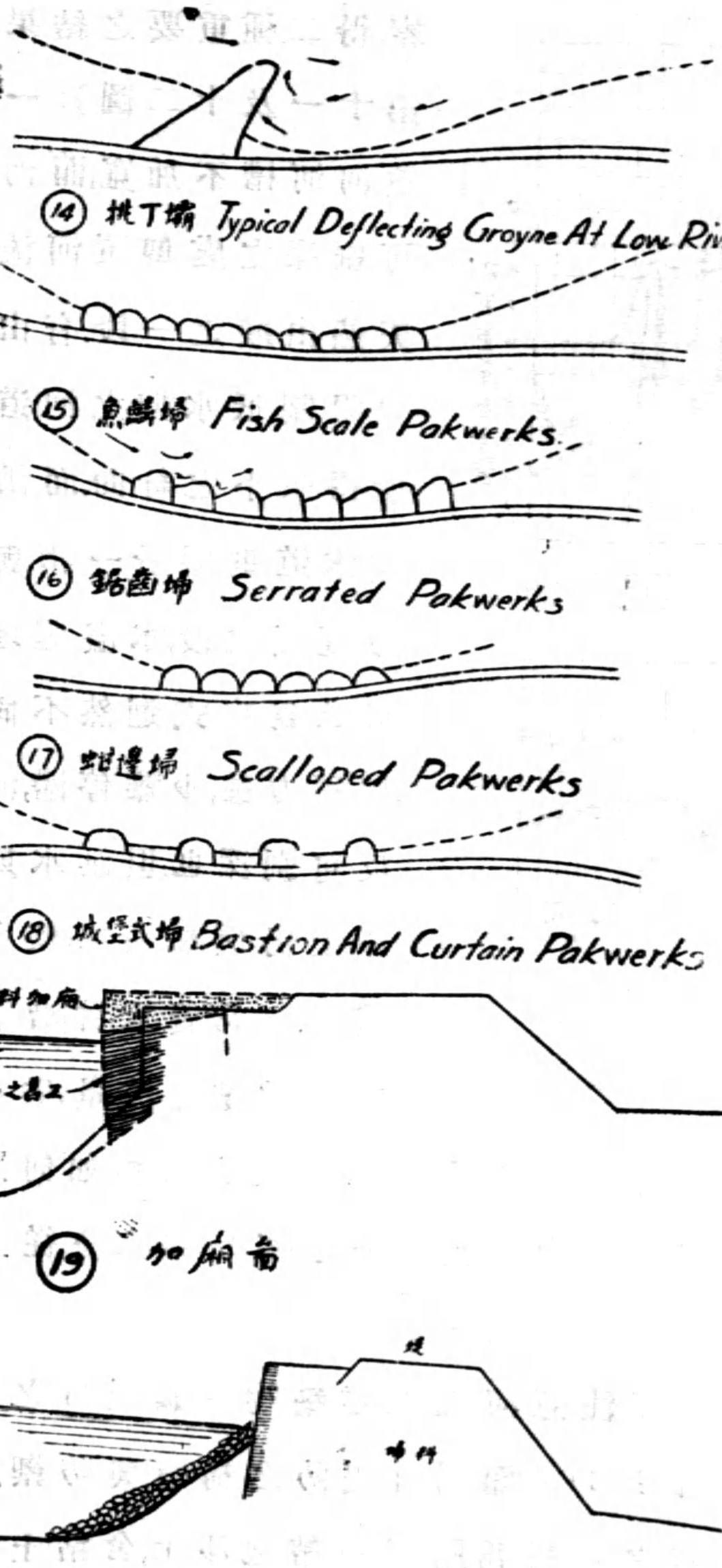
費禮門氏又曾精密考



(13) 河床變遷圖

察,得二種重要之結果(第十一及十二圖):一爲黃河河槽不加寬,而河床可刷深之處,即黃河流行天然山峽之一段.有山峽之限制,低水期之河道,僅能得微小之紆曲.而洪水期水道則限於一槽,與隄防寬闊之段,水溢灘地,槽形成爲複式迥然不同.故抑轉力強,沙難停滯,河床反可刷深也.但洪水期過,沙土仍填塞河床,恢復原狀矣.一爲費氏曾沿下游實測數處之流量,砂量水位及河床高度而比較之,並觀察各地河床被侵蝕之沙土沈澱物,如何遷移(第十三圖).於是發現此種遷移無常之沙土,僅有一小部分爲水流從上游擠挾而來之黃土,大部分則爲當地被冲刷之沙土.

苟欲計畫治理黃河改狹河道,亦應注意河上之建築物.一爲滎口之津浦鐵橋,一爲鄭州之京漢鐵橋(經度113°30'),而固有隄防之構造,與防禦之方法,亦皆有考究之價值(十).舊隄防之質料,爲附近一帶之沙土,含粘土甚少,頗易滲漉,故堤之尺度不得不大.隄防之寬自八公尺至廿三公尺不等.兩旁坡度爲二與一之比.隄頂約高出洪水面二公尺至三公尺.堤工甚堅,但缺青草護蓋堤坡.由此可證明堤之外坡,恒峭立如壁之故,蓋河身彎曲處,日漸冲刷堤基,而及堤坡.堤坡既缺少掩護物,迨侵蝕過甚,而成峭壁也.且堤坡無草,



⑭ 挑丁壩 Typical Deflecting Groyne At Low River

⑮ 魚鱗埽 Fish Scale Pakwerks

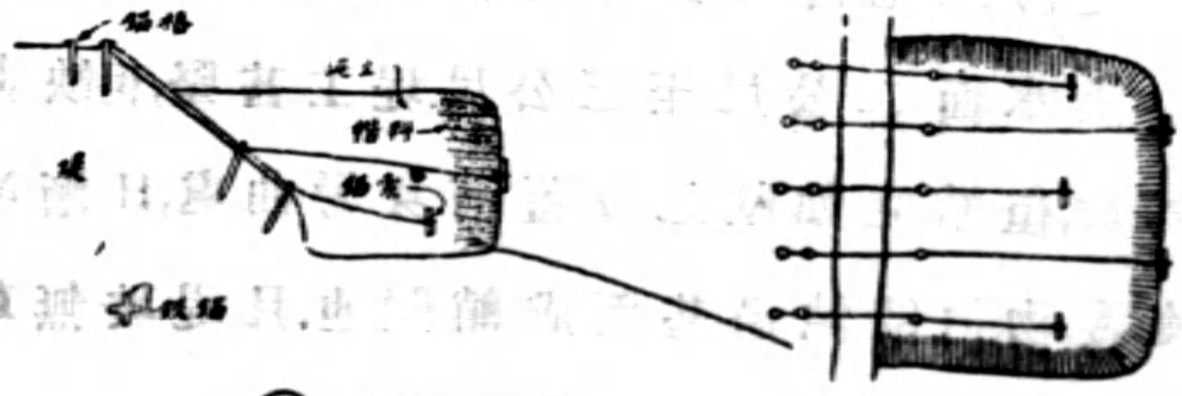
⑯ 鋸齒埽 Serrated Pakwerks

⑰ 蚶邊埽 Scalloped Pakwerks

⑱ 城堡式埽 Bastion And Curtain Pakwerks

⑲ 加廂畨

⑳



㉑ 剖面圖　　平面圖

凡遭大雨,水從堤坡下流,漸成深溝,而堤身頻危矣,故洪水期內最危險之隄防外,恆另施掩護工.灤口以下一段,爲防隄起見,曾用秸料或石料編成挑丁壩伸入河流,以抑水勢,不使直接冲刷堤基.壩身且高出洪水位（第十四圖）.有:數段,間用楷料編成魚鱗又鋸形等狀之埽以掩護堤岸者（第十五,十六,十七及十八圖）.埽端爲不規則之突出形,取其能殺水勢也.洪水之後,埽多沉墊,則添加新料,是爲『加廂』（第十九圖）.更有護岸之建築物,或採用石料,以取其堅實(第二十圖).尤堪注意者,於堤防危險之處,搶築險工,其法使埽料與堤身用樁簽聯合一氣,尙亦救急之道也（第二十一圖）.至若埽料編織物之技能,及堵塞決口之方法,與荷蘭及北德一帶根本無大差異.是以各國工程師目睹中國河防工程者,莫不同聲讚歎也.

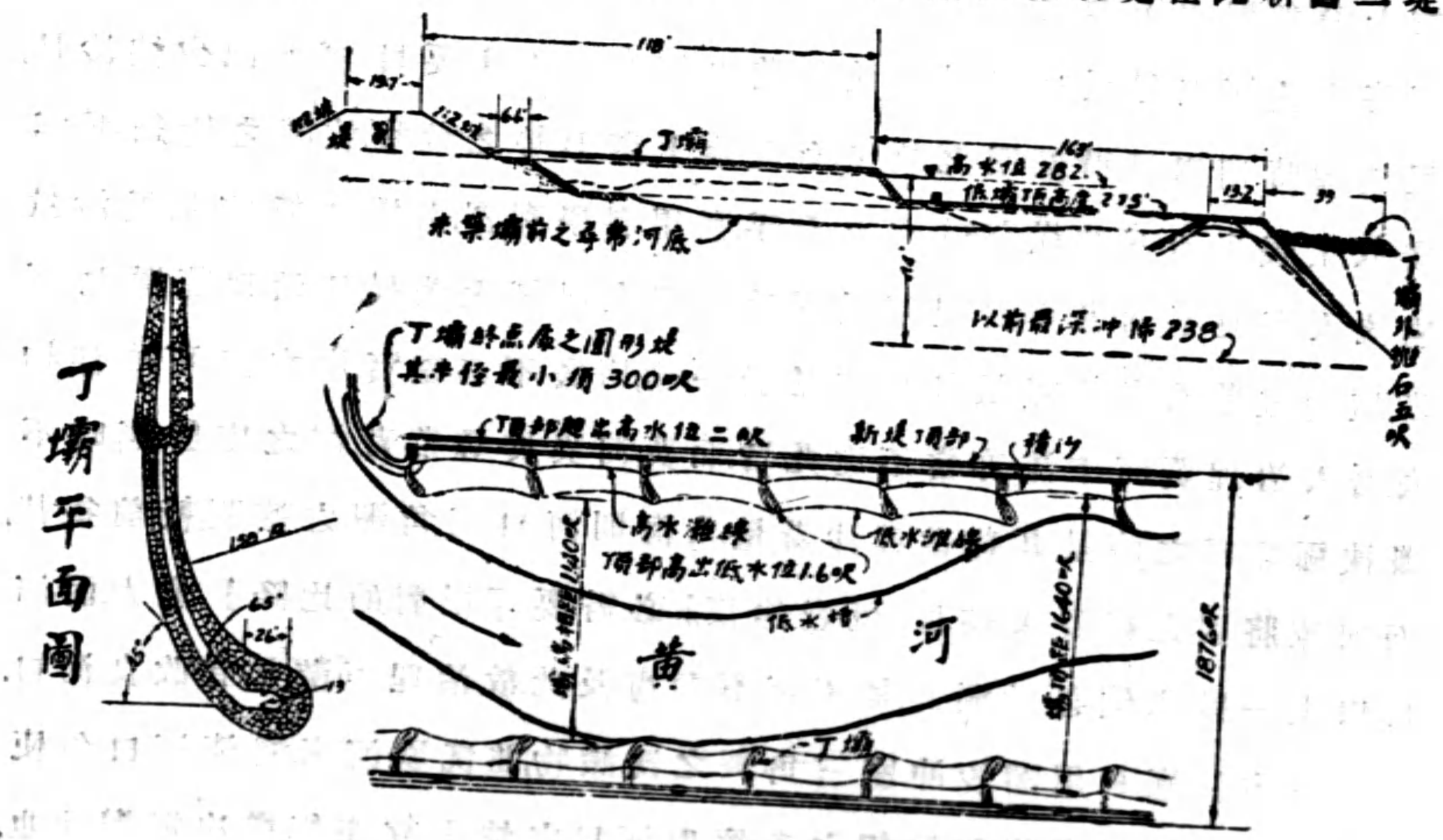
(二)治理黃河之商榷

治黃可應用治理荒溪之原理,一首宜改良河口,不必顧及航運,一費禮門主張建築新堤束制水位河床,免除河床增高,添設丁壩以防水流侵堤.一恩格司主張固定中水位河槽.一舊堤保存加以修葺,並植草掩護.一治黃實文化事業.

黃河之治理,首在制馭下游『制馭』云者,本歐洲治理『阿爾本』山域荒溪之名詞也.今用之於黃河,蓋黃河之性質,固亦大規模之荒溪耳.『荒溪』者上游水行山地,承納小流,來自山嶺勢陡流激,碎石沙礫隨之而下,所謂山水者是也.荒溪約分三部:曰『集流區』曰『集流槽』曰『冲積洲上之流道』.凡治理荒溪者,必先整理上部,然後可確定冲積洲上之流道.惟黃河以規模偉大,似不必以此公理繩之.雖據津浦路黃河橋之計劃書中所云(九)苟黃河經過之山嶺未盡植林,而暴雨或山水可自黃土層上直馳入河,或黃河自身可無限制的冲刷黃土之岸,則下游河床增高必無已時,流道變遷亦難確定.又單一氏曾本荒溪護岸之旨,擬定治河計畫.余工程浩大,足與長城相埒,結果未必有十分把握.夫上游中游之護岸計畫固不可少,考之治河原則,亦須正本清源,務使全河工程,脈絡相關,以免分道揚鑣.惟治本主要目標,如減少挾沙量,又豈短時期內可得顯明之效果.而觀察下游形勢之危險,救護之策急不容緩,故主張先治下游,從『疏』字上着手.應用科學利器,引導全部水量及沙量暢流入海,使不爲患.與治理荒溪下游,原理上固無大差異.凡治理荒溪之下游,恒於流道兩旁築隄,限制水流,聚於一槽,槽底不必堅實,使水流可刷深槽底.吾人治理黃河下流亦當不違此旨.而黃河異於尋常荒溪之處,即無時不攜挾極豐富之沙量耳.苟欲導沙盡量入海,則河口三角洲之擴張,較前益甚,而河流將因之變長,求恢復『恆壹態度』必需要『絕對的比降』愈大,而河口以上一段水位必致漲高,是不可不顧慮及此.故治理下游,首宜改良河口.其根本方法,應利用潮汐冲刷三角洲之沈澱物,並洗刷河床,澄清河口,勿使淤塞.至若精密計畫,以無詳細之考察,與河口之情況,故亦無從決定辦法也.

治河兼顧航運,固屬要舉,但就黃河下游航運之零落而論,亦非十分重要.設祇求防患,不顧舟楫之航行,則治理下游,工易而費少,蓋河流供航運用者,則預定河之橫斷面時,須求低水期及洪水期俱不礙及航運爲宜.所需要者:一爲適當之水深,一爲適當之河寬.設兩岸已有隄防,則洪水期之河面爲堤所限,不得展之於寬,勢必納之於深,水流之押轉力必因此加大面而害及河身.若欲河面加寬,必先將隄距改大,使隄外灘地加寬.再於二隄之間,確定常水位之紆曲流槽,堅築河床以防遷移.然折毀舊堤,加寬河面,與另築新堤,工艱費鉅,殊非經濟之道也.

費禮門之建議曰:黃河之爲害在堤防距離之過寬,與河流向兩旁擴充毫無拘束.治理之道,宜使河道完全伸直,另築新堤與高出洪水位之『挑丁壩』,以造成統一之洪水流槽.而洪水之押轉力須足以刷沙,流溜又不致洗刷河床爲宜.查黃河在孟津以上一段之河流,兩岸夾山,水力足以刷沙,可資佐證(第十一及十二圖).茲摘錄費禮門之報告『治理黃河之問題,在使黃河流行於一狹直河槽中.其方法擬於現有內堤之內,另築直線新堤在此新舊二堤



(22) 費禮門計劃之新河槽及堤壩之佈置

(23)　費禮門計劃之新河剖面

空留存中之溢水洪任,地入,俾可沈澱淤高,可資將來之屏障.如遇特別洪漲,並於新堤與河槽之間,建築挑丁壩,以防新堤崩潰(第廿二圖).苟能實地加以:更精密之考察,或於試驗室中從事更深切之研究,則作者所提出之建築物,其方向與尺寸,當可加以改正也.茲特將計畫大概情形,陳述如下(第廿三圖):現有河槽,當設法改直,其長度自五哩十哩至二十哩不等.選擇河槽之地位,宜在現有內隄之正中,然亦當因地制宜(第六圖).洪水河槽上部之寬度,擬定爲三分之一哩.兩堤頂之距離約爲半哩弱,用以代現在四哩至八哩之河面.至若河流如何導之注入新槽,必須應用各種設備,而對於天然流水之冲刷力,尤宜充分利用.在新舊堤中間所留約二三哩闊之地帶(第廿二圖),將漸次淤墊,將來或可與洪水齊平,積沙之地極爲肥沃,可資耕種.積淤之法,應在堤上多建閘門,以司啓閉,耕種時則閉閘以拒水,收穫之後,則啟閘以納水.洪水攜挾之淤泥,因以沈澱,成爲沃壤,極利於農作物也.俟新舊兩堤中間之地,淤積之高與普通洪水位齊平後,雖遇異漲或特別變故,即此二哩寬之新淤地帶,當可減殺水勢,屏障堤防,不致驟然崩決,演成一八八七年與一八五一年所發生之慘劇,亦不致發生如歷年紀載中無數量之損失也.

荷蘭工程師單氏亦曾建議,築堤束小洪水位之河面,增加冲刷力,以治河床之墊高,蓋卽築堤束水束水刷河之遺意.費禮門並主張苟因地方情形之需要,不妨於新河道內,安設短曲之彎,以變流道之方向.且願仍採用中國堤防,及高出洪水位之挑丁壩,以免洪水侵堤.所不同者,中國之築挑丁壩,在灘地已冲刷盡淨,水流將危及堤坡之時.而費氏則預築挑丁壩於灘地之上,從

事預防.挑丁壩之間,每經洪水可淤積填塞,使堤防之外,多得一種保障云.

按費氏計畫果能實施,則黃河河床墊高,與堤防崩潰,必可避免.惟計畫之如何實施,似宜審愼考慮耳.按諸治河通例,中水位之流槽不可不固定,而流槽形態恆爲之字形.費氏之洪水槽其直如矢,殊不適於中水位河槽.違反天然,恐難求功.且費氏改狹之新河床寬度,僅當現今河床八分之一至二十二分之一.則新河床未經刷深之際,洪水面必致壅積漲高.其何以障之勿使泛濫.或以爲築堤束水,可自孟津始.該處山坡夾流爲天然狹隘之段.新堤之上水面壅積,有山坡障護,無外溢之虞.然新堤之建築,段節相續,進行甚速,河床之刷深,非朝夕之功,爲避免泛濫起見,故孟津以下之新堤及丁壩之高度,均須超過此最高之壅洪水面,而洪水之壅積預計有數公尺之高.若爲此暫時之洪水壅積使堤身加高數公尺,則日後河床已經刷深,堤高遠超過尋常洪水位之需要,損失之資應爲幾何?況築堤之時水面壅積,其下游未築堤防之處,水勢將益爲猖狂,舊堤之抵抗力素弱,恐決口之警較之未治以前益頻矣.

費氏之建議,既恐有上述之患.因另擬治理之計劃.但著者未嘗親臨河濱,詳加觀察,亦不敢認所建議者爲當也.姑言之,以供當代水利家之商榷.竊按黃河之病,不在堤距之過寬,在缺乏固定之中水位河槽.故河流於內隄之間可任意屈曲,遷徙莫定,害乃生焉.河流遷移無常,卽易荒廢.故抗轉力弱,沙礫淤積,河床墊高,或河灣屈曲愈銳,日近堤防,冲刷堤基,洪水一至而崩潰堪虞矣.治理之道,宜於內堤之間,固定中水位河槽之岸.河灣過曲則裁之取直.河流分歧則塞支强幹.其利有二:一爲中水位河槽之『路線』或名『谷道』可固定不移.一爲河流之力可刷深河床,不致展之於寬,而河床之墊高固可避免,河灣亦不致近堤矣.且邊濱之灘地,亦可保有無恙.當洪水大漲之時,水溢出槽灘地之上,可淤積沃壤,日漸增高.卽中水位河槽,日益加深,冲刷力可將因此以增大.固有堤防之不規則者,亦宜修治.搶險之掩護工程如挑丁壩之類,可以折衷.惟堤身多栽植青草,以資扞護,一則防水流侵蝕,一則防雨水冲

瀉.而安設涵洞,引水灌田,宜有完善計畫,緣涵洞爲堤防弱點,不可不愼也.

中國近時選派青年求學異邦.他日歸國,以歐洲學理與中國固有之水利經驗相印證,必能造詣甚深,爲祖國造福.按中國水利問題,實爲全世界之最繁難而浩大者,卽如黃河之治理,必得數十百萬人之經營,始克奏效,未來之空前文化事業,其在斯邦乎.

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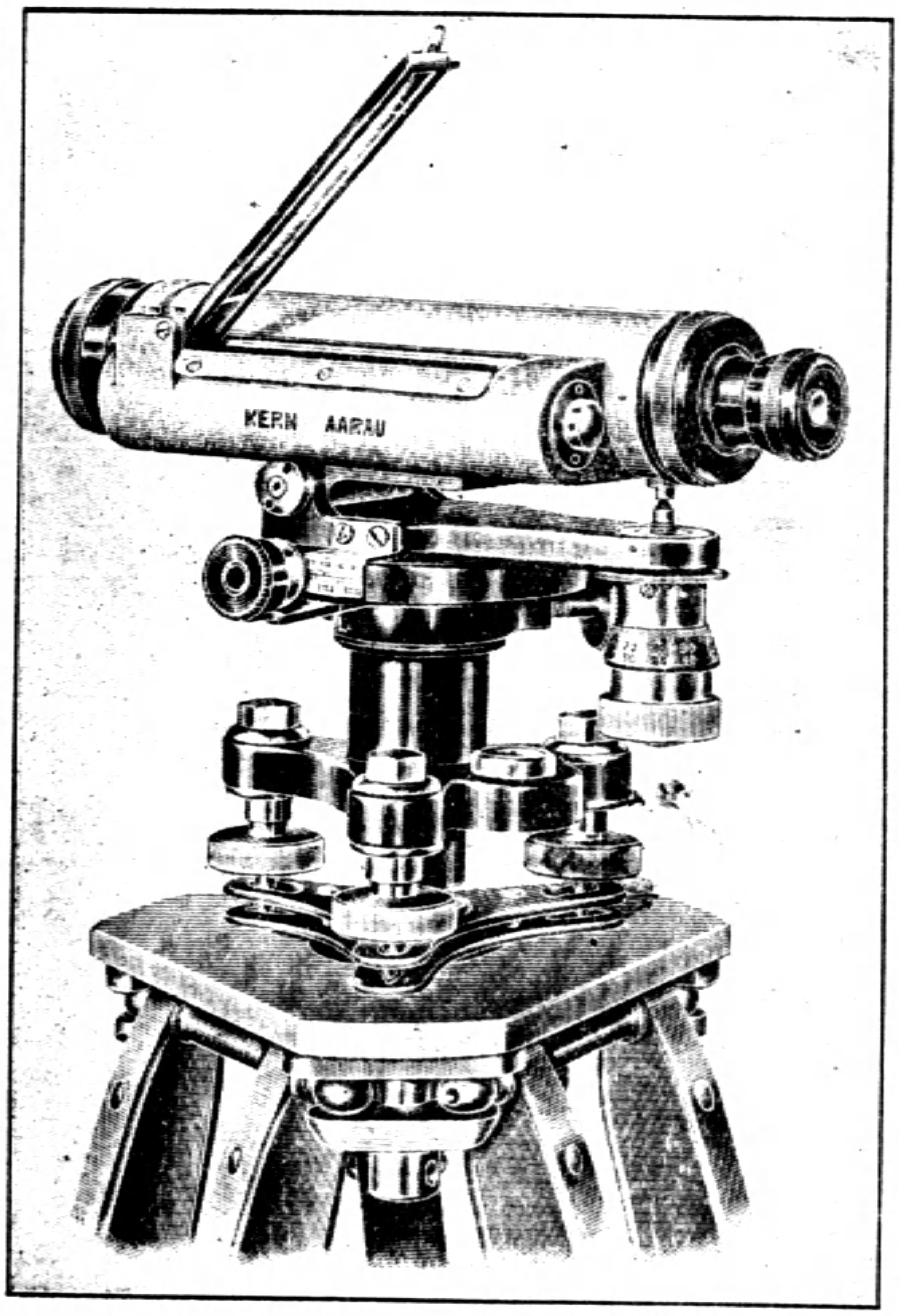
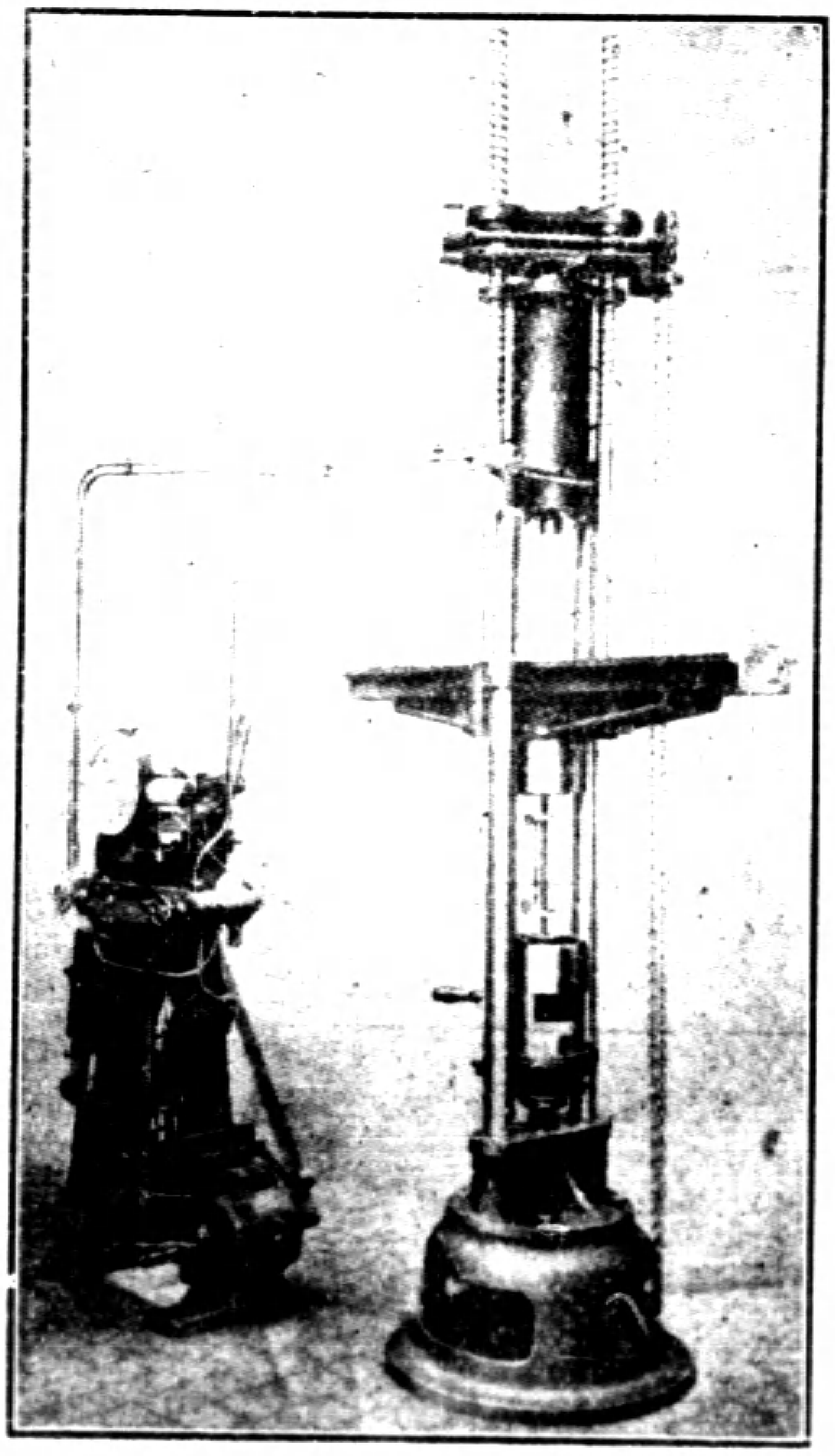
竊按黃河之爲患,由來久矣!吾國朝野上下從事防禦,亦可爲殫精竭力,無微不至矣!然歷年以來,河道遷徙,隄防崩潰,靡耗頻傳,舉世震驚;豈天命之難知,實人事之不藏.嘗考吾國水利之興,肇自上古,工程學術爲世界冠.比者西方科學,雖日進千里,而歐美人士目覩吾國水利工程者,猶莫不欽佩讚歎.然則黃河之患,胡爲乎終未絕跡耶?曰歷年治河,祇知治標之謀,而未得治本之

道,祇知局部之補救,未得全部經營之計劃也.近數年來,北方潦旱洊至,災情重大.舉國人士大爲覺悟,莫不以爲水利失修,亟宜治本,而不專以賑濟蠲課爲急務矣.奈兵災匪息,紛至沓來,大局日危,民不聊生.更以國家財政支絀,羅掘俱窮,雖有宏願,一籌莫展.而歐美學者獨能於研究學術之餘,爲我策謀,以爲黃河爲患最巨,首宜治理.調查考求不遺餘力,著論立說共籌善策.噫,吾人能不感且愧乎!先是民國八年吾國聘請美國工程師費禮門氏 Freeman 考察黃河,圖加治理,終以工程浩大,經濟困難,事遂中輟.費氏歸國著 Problem of China 一文,民國十一年夏脫稿付梓.費氏本其實測黃河之情形,擬定治理之方策,請求世界水利名家共同商榷.民國十二年春,德國薩克遜大學教授恩格司博士 Engels 又採集歐美名家遊歷中國北部考察黃河之狀況,參合費氏最近實測黃河之結果,另著一文題曰『制馭黃河 Bandfgung von Woang-ho』先生耆年碩德,誨人不倦,德國水利家之名宿也.先生文既脫稿,出示鄂等曰,

『黃河爲中國大患,年來余研究治理之道甚勤,惜未身臨黃河之濱,閉門造車,出門焉期合轍;苟余於衰邁之年,猶得遊歷中華,實地考察,幸莫大焉!』嘗念恩氏學術邃深,苟能來華視察黃淮,一切治河方策當可因以釐定;二濱安瀾之兆,其將繫諸此行.十三年孟夏余歸國後,因商諸蘇省當局,期由蘇皖及沿河數省共同聘請恩氏,作短時期之考察.奈未有成議,而齊盧啓釁,事乃中輟,殊爲遺憾.爰將恩氏原著迻譯,廣爲介紹.更願引起國人之興趣,對黃河自下研究工夫.蓋吾國治河歷有年所,經驗豐富,著作繁多,苟求根本治理,決非外人短時期之考察,所能作爲準鵠.而觀察數十百年來黃河之變遷,端賴歷代文獻,稽考文獻,責在我等.費恩二氏之論,僅爲草創之作,日後實行治河,尙須精確考查,審古度今,治法乃定.且工程之大,既屬空前絕後,費用之鉅,又豈一呼可集.苟專仰給於外債,可異挖肉補瘡.所望國內政治上軌,人民覺悟,生聚休養,庶政乃興.庶乎治河方略早日確定,逐步實施,安瀾可期,實吾人所馨香禱祝者也.

十三年孟冬鞏經附識





南寧電燈整理之成功及方法

著者：張延祥

廣西南甯之有電燈，迄今已十三年，公司係商辦性質，自創辦至今，未曾分派股息一次。每年收支數目，幸可相抵，惟添機購線等項，均須另行籌款。據云所投資本總額，已逾桂幣二十五萬六千元之巨，(約合國幣十六萬元)，而廠中機器之發電量，不過二百四十三啓羅華德 (243 K. W)。每夜發電復時斷時續，電壓低落，電力不足，燈光發紅色，甚至有稱之『燈光如螢』，或稱『香光』者。此種腐敗情形，爲國內各處小電燈廠之通病，實不鮮見，亦非言之過甚也。

廣西建設廳屢次派員澈查，設法整頓，機廠情形以及擴充計畫，刋載於廣西建設月刋第一號，其後南甯市政籌備處亦擬具整理計畫。無如公司方面，一則因電燈專利年限將滿，不願再行添機，二則因歷年無利可圖，股東視若畏途，且又時聞政府收回之呼聲，更不敢再投巨資。因循數年，愈趨愈下，而市民直接及間接二方感受痛苦更深，交通治安，尤受影響。於是電影院，大旅社，無線電台，大機關公署，均自備發電機，極爲不經濟。今年二月，省政府以南甯爲省會之所在，電燈乃觀瞻之所繫，不能不積極整理，乃電召著者赴邕，設法進行。著者留邕旬餘，第一星期調查電廠病源，第二星期實行改革，旬日之間，全城各街，大放光明。因思此項通病，爲國內各小電廠所共同者，或者他處亦可依法泡製，一革積弊，因略述整理之方法及效果，分段敘述；(一)設備略述，(二)現狀及病源調查，(三)改良計畫及籌備，(四)實行步驟及効果，(五)結論。

(一)設備略述

(甲)發電廠　發電廠有四座本炭煤氣機 (Charcoal Producer Suction Gas Engines) 分汽缸，發動機，發電機，及電鎗版四部，茲將詳細情形，列表錄下：—

	第一機	第二機	第三機	第四機
發動機(引擎)製造者	德國Guldner廠	英國Imperial Keighle 廠	同第二機	英國Gardner廠
〃 〃 式樣	立式	臥式	〃	立式
〃 〃 汽缸數	2	1	〃	6
〃 〃 伸復數	4	4	〃	4
〃 〃 馬力	——	——	——	——
〃 〃 轉數	180	——	——	514
〃 〃 號碼	——	7500	7501	——
交流發動機製造者	德國 Garbe Lahmeyer廠	美國 General Electric Cc.	同第二機	美國General Electric Co.
〃 施動式	皮帶傳動	同	〃	同
〃 發電量	83 K.W.	40 K.W.	〃	75 K.W.*
〃 電壓力	2300 V.	2300 V.	〃	2300 V.*
〃 每線電流	22.1 amp.	10 amp.	〃	.....
〃 相數	3	3	〃	3
〃 週波	60	60	〃	60
〃 每分鐘轉數	1200	900	〃	900
〃 電率 P.F.	1.0	1.0	〃	.....
〃 號碼	FJ 1000/90B No.151217	ATB 8-75-900 No. 302478	.....	* 無名牌
直流勵電機發電量	1.7 K.W.	3 K.W.	〃	.....
〃 電壓力	115 V.	125 V.	〃	.....
〃 電流	15 amp.	24 amp	〃	.....
〃 施動式	直接發電機	同	同	同
〃 號數	RP 30 A. No. 142961	.....	EF 4-3-900 No. 501264	無名牌

各汽爐均有生汽爐 (Generator), 洗氣爐 (Scrubber), 及淨氣爐 (Purifier or Saw Dust Scrubber).

電鎗版各有三極油浸開關 (T. P. Oil Circuit Breaker), 其二極有電流限制自動保險機關 (Time Limit Overload Relay), 又各有電流表二個, 電壓表一個, 以及勵電機之電流表及電壓表.

四座發動機不能合併開行(not synchronizing)故三相發電機每機有三線出廠,各管一路,不相連絡,各有佈電開關(Feeder Oil Switch),惟其自動機關多已毀壞矣.

(乙) 高壓線. 每發電機係三相式,故有三條高壓線導出,電壓爲2300伏爾次,四座機共十二條,第一號機又岐出一路單相電,計二線,故共有十四線出廠,其路線圖因無關重要,故不製版刋印.

(丙) 變壓器. 變壓器均係單相式,裝置柱上,其高壓爲 2300 V., 低壓爲 115 V.,全市變壓器數目及容量列表錄下.

	第一機路線		第二機路線		第三機路線		第四機路線		總　計	
	數目	電量	數目	電量	數目	電量	數目	電量	數目	電量
3 K.V.A.者	2	6	——	——	2	6	——	——	4	12
5 K.V.A.者	9	45	3	15	3	15	10	50	25	125
10 K.V.A.者	5	50	4	40	4	40	3	30	16	160
20 K.V.A.者	1	20	——	——	——	——	——	——	1	20
總　數	17	121	7	55	9	61	13	80	46	371

依上表可知發電機之總量爲 243 K.W.,變壓器之總量爲317 K.V.A., 故變壓器之數目及電量,足敷發電機全量之用也.變壓器分配位置,曾調查繪圖,惟無關重要,故亦不製版刋印.

各變壓器並非一家所製,而低壓之電壓又不一致,大多數爲 230/115 V. 之雙圈四線式,係美國之所通行者,其低壓四線,可併作愛迪生氏之三線式(Edison 3-wire System),兩外線之間爲230 V.,兩外線之任一線與中線爲115 V., 如此則低壓線路之損耗可減少,而戶內用電仍爲115 V.,並無 230 V. 之危險. 今南寧電廠並不用此種三線式,而用 115 V. 之兩線式,即用雙圈並行接法(2 coils in parallel), 雖云節省電線,而電壓力低落矣.

全市變壓器經詳細調查,編列調查表,記載下列各項,此項調查表對於整理進行,大有効力,(全部調查表因無關宏旨,故不錄).

南甯電燈整理委員會調查變壓器表格式:

第三號機路線 ⊙ 調查日期：民國十八年二月二十四日									
指數	地址	離廠遠近	容量	高壓	低壓	製造者	製造廠號數	接用電相	附註
		呎	K.V A	VOLTS.	VOLTS				
26	安塞門街	620	3	1150 2300	115 230	美國 MOLONEY	HE-1- 44114	紅·藍	

(丁) 低壓線. 從變壓器接出之低壓線,亦經詳細調查,繪註圖上,低壓線均接一百十五伏而次(115V.),前已述及,惟每晚低壓方面究竟有若干電壓,以及每線所載電流,因時間侷促,未曾一一試驗,大概晚上七八點鐘時候,電壓平均爲40—50V.,而5K.V.A.變壓器低壓方面所負載之電流爲80—90安倍,即約一倍於應當之數.

(戊) 用戶方面. 依發電量而言,243K.W.除一成(10%)之線路損耗外,實餘219K.W.之電力,可以供給用戶.十六支燭光電燈以二十華德(20 Watt)算,則該廠設備全量,可供給一萬一千支燈數.依公司裝燈紀錄,目前各用戶及路燈,已超過此數,而用戶自行加多之燈枝,無從稽查.且用戶所用之燈泡決不能一律用十六支光者大者,至一百華德之燈泡.用戶裝電錶者計三百餘戶,包燈者計六七百戶.從此觀察,則機力不足,求過於供,已無疑義,惟無論如何,燈數增多,需電超出數目,不致使全城燈光如螢,或致如香光,其中必有他故也.

(二) 病源調查

(甲) 機廠病狀. 該公司未聘工程師,廠務一應付諸大機(即上海所謂老管)之手,以致弊病百出.機件佈置無論已,即皮帶傳動亦不能依理將皮帶盤對直,以致每年皮帶損失亦屬可驚.各機每夜開動,並無休息整理之機

會,故冷水層內積淤甚厚,失其傳熱作用.第三號機之汽缸頭(Cylinder Head),因之破裂漏水拆卸審視,則裂縫至五六處之多,有長至七寸餘者,滲滲射水,使燃燒室(Combustion Chamber)熱度減抵,馬力減少,又不能開足速度,其第二號機之火星塞(Spark Plug)及麥尼多(Magneto)復損壞以致每三次必有一次不着火.其第一號機之冷氣開車機關無用,每日開車時用十餘人拖動皮帶,又二人司啓閉冷氣凡而(Compressed Air Starting Valve)之責,其事誠屬可笑可嘆.諸如此類,不勝枚舉,其腐敗狀態,有如病入膏肓也.

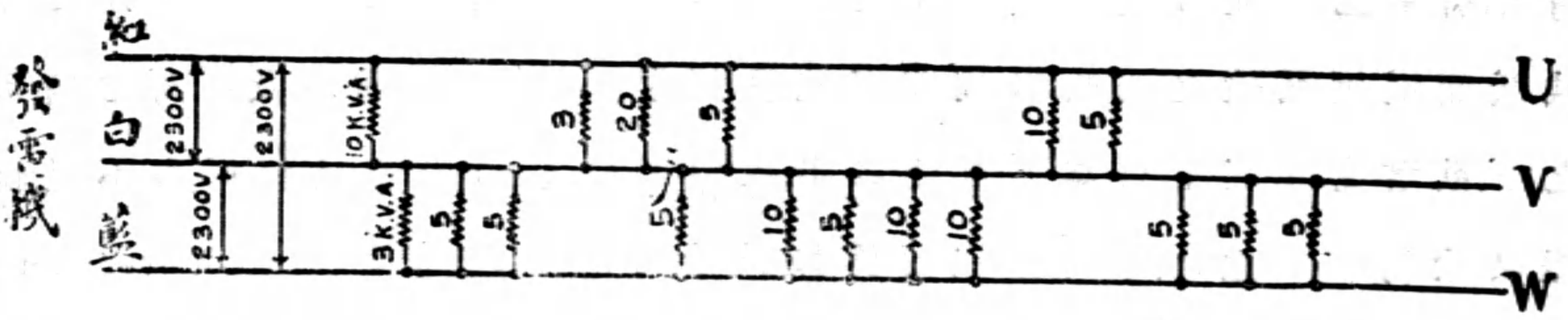
每日下午五時餘,機房升火開車,至翌日天光時停車,開車之後,將總開關推上,然後將電壓調整器(Shunt Regulator)逐漸開大,電壓逐漸升高.然2300 V.之電壓,祇能開至300-1000V.,不及半數而電流已至全量之上.如第三號機之電流足量爲10安培,乃電壓僅開至300 V.,而電流已15安培.若電壓再行升高,電流更大,使油開關之自動保險機關運轉,將線路打斷.該保險機關定在150%之處.若將油開關強制推住,不使自動保險機關運轉,則電流增大,電力隨大,引擎已不能負載全量,而速度減低,若引擎速度減低,發電機之速度亦減低,而電壓又隨之減低.以故在電流已超過150%,電壓尚不及50%之情形之下,欲增高其電壓,實爲不可能之事.推原其故,(一)引擎已舊,馬力不足,祇能供給約75% 之力.(二)發電機負載過量,乃電流之過量(Current over limit),而非電力之過量(not power overloaded).如第三號機,原定發電量爲$\sqrt{3}\times 10$ A. $\times$ 2300 V. = 40 K.W.,今僅15 A., 800 V.,則電力爲$\sqrt{3}\times 15\times 800 = 20.8$ K.W., 並未超過原量,實祇及其半數耳.故斷定其線路有短接之處,或僅有極低之阻力(Low resistance)而已.

(乙) 線路病狀. 線路之短接,分高壓及低壓二層檢查.高壓線已舊,尚不至有短接之處,通地之阻力(Earth Insulation)有 2—10 Megohms. 亦不致漏電.惟查各變壓器之接法,則大謬不然,蓋高壓方面三線,假定分別之爲『紅』『白』『藍』三線,『紅白』兩線間之電壓爲 2300 V.,『白藍』兩線間之電壓亦

爲 230V.,『紅藍』兩線間之電壓亦爲 230V. 令各處變壓器均係單相式,接用任何兩線,惟『紅白』『白藍』以及『紅藍』三相間,務必分配使其供電平均,則三線所通之電流數不大,而所傳之電力可足.今從調查結果,證明該廠工人,並無此項智識,所有第一第二第三號機路線之各個變壓器,均接於『紅白』及『白藍』兩相間,而『紅藍』之一相,則完全不接.第四號機路線之變壓器,想又爲另一工人所接,因彼雖知三相互用,而亦不能平均之.今以四路變壓器所接之情形,列表並繪圖以明之:

變壓器	『紅—白』電相 U—V	『白—藍』電相 V—W	『紅—藍』電相 U—W
第一號機路線	48 K.V.A.	63 K.V.A.	0
第二號 „ „	30 „	25 „	0
第三號 „ „	26 „	35 „	0
第四號 „ „	15 „	30 „	35 K.V.A.

第一號機路線所接變壓器之圖式:——



(丙) 燈泡之病狀. 高壓線方面除變壓器接線三相不平勻之弊病外,實不見有短接之處.於是從低壓線方面檢查,低壓線實太腐爛,入屋亦不用保險鉛絲,故因用戶內線之破爛而致電線短接者,乃屬可能之事.惟每個變壓器之高壓方面有保險鉛絲,即使低壓線短接,該變壓器鉛絲即燒斷,或變壓器自已燒壞,亦不致影響於全體也.後從用戶之燈泡方面查出發電機之短接病狀,乃由於用戶濫用低壓力之燈泡,僅有極低之阻力,以致電流多而電壓低.正如試驗電機烘乾線圈時,將發電機用低阻力之短接法(Short-circuited with low resistance)而使電壓減低至足量電流爲度.今該廠每日開車,實非供

給電力,而乃作電機烘乾之試驗耳.

究竟用戶所用之低壓燈泡為害至若何程度,則著者曾逐戶加以調查.茲舉倉西馬路用戶六家之實況錄下,可例其他也,

南甯用戶裝用燈泡之調查　(十八年二月二十日)

華德	100 V	80 V.	60 V.	50 V.	40 V.	32 V.	24 V.	16 V.	12 V.	總共華德
粵西號	3×25 3×15	3×40 1×15	1×25	7×40						WATT. 560
贊興號	1×40 1×15	7×25	1×25	1×60 4×40	4×15 1×25					1100.
民發號	1×25			3×25						100.
妙熙綸	4×25	1×60 5×40	1×60	1×25						445.
信益號	1×60 1×40 3×25	6×60		4×60 6×40						1195.
智利號	3×60 3×40 3×25	1×60 6×40	4×60	6×60 2×40	1×25			14×25		1580.
								總　共		4980.

用戶方面之燈泡,既如此繁雜,而電器店中所陳列者,更千奇百怪,萬,樣俱備.用戶購買12 V., 16 V., 24 V., 32 V., 等燈泡,以備晚上七時至九時電燈最黑暗時之用.所以白天調查未曾見到在用戶所述之理由,以100 V.足力之燈泡,既比香光尙暗,不得不購用低壓泡以圖略放光明;在公司方面,實大受其害.公司不早取締此項低壓泡,實為公司之咎,然追源禍首,則南甯電燈之黑暗,南甯電器店實一大罪人也.若電器店不運售低壓燈泡,用戶自不願向港滬購買之煩.欲說明低壓泡燈之害,不厭詳細述其理由.

據以上所舉六家用戶之燈泡計算,設若該六家完全將燈開足,依華德總數,不過4980華德,或4.98啓羅華德.若全用 100 V. 燈泡,則電流不過 49.8 安培,其總共電阻力需2.01歐姆 (Ohms). 今因用低壓泡,每燈之阻力減少,電流加大,至於增多實際數目,列表如後.

各種電壓燈泡之電阻力表（歐姆 OHMS）$R=\frac{E^2}{P}$

P \ E_1 R	100 v.	80 v.	60 v.	50 v.	40 v.	32 v.	16 v.
15 w.	667	427	240	167	107	68	17
25 w.	400	256	144	100	64	41	10
40 w.	250	160	90	62.5	40	25.6	6 4
60 w.	167	107	60	41.7	26.7	17	4.3

各種電壓燈泡若在100V.之電壓時所需之電流（安培AMP.）$I=\frac{E_2}{R}$

P \ E_1 I	100 v.	80 v.	60 v.	50 v.	40 v.	32 v.	16 v.
15 w.	.15	.23	42	.60	.94	1.47	5.90
25 w.	.25	.41	.69	1.00	1.56	2.44	10.00
40 w.	.40	.62	1.11	1.60	2.50	3.91	15.65
60 w.	.60	.85	1.67	2 40	3.75	5.90	23.3

依據上兩表所列,計算前所舉用戶六家用低壓燈泡之影響,再列表比較:-

	用燈華德總數	若用100 V.燈泡所需電流	用低壓泡若公司發電100 V. 則所需電流	上二項之電流比較倍數
粵西號	560 watts	5.6 安培	15.18 安培	2.7
贊興號	1100	11.0	51.97	4.7
民發號	100	1.0	3.25	3.25
妙經綸	445	4.45	7.62	1.7
信益號	1195	11.95	28.85	2.4
智利號	1580	15.8	165.38	10.4
總計	4980 watts	49.8 安培	272.25 安培	平均 5.46 倍

低壓燈泡之電阻力小,例如上六家若全用1000 V, 之燈泡,則電阻力應爲2.01 歐姆,今用低壓泡,其電阻力小至$\frac{2.01}{5.46}$ = 0.368 歐姆.至此,而上述之電廠病源,卽線路有極低阻力之短接 (Short-circuited with low resistance), 及尋得究竟.

低壓燈泡如10 V., 16 V., 24 V., 32 V., 40 V., 等,若用在100 V 之電壓,固然立刻燒斷,但從 50 V. 以上之燈泡,即使用 100 V. 之電壓,亦不定立刻燒斷.且外面所接低壓燈泡如此之多若欲發電機開足100 V., 卽電流須要到五倍餘之大.今開至35%之電壓,而電流已超過容量至150%再想開足電壓,乃不可能之事.因交流發電機有一種特性,其機內之阻力 (Impedence) 甚大,卽使十足碰線短流 (Dead Short-circuited), 其發出電流亦不過三四倍之數,萬不能令其供給至五倍餘也.然則如何可望其開足 100 V, 燒去低壓泡而放光耶.

今再試算其用低壓燈泡後,究用到若干電力?依上表中,該六處用戶所裝之燈泡總共 4.98 啓羅華德.今用低壓泡,電壓力祇有$\frac{800}{2300}\times100=34.8$ V., 電阻力則爲 0.368 Ohms 歐姆,其電力爲:

$$P.=\frac{E,2}{R}=\frac{34.8\times34.8}{0.368}=3,28 \text{ K.W.}$$

如此可見電力反少用,僅得$\frac{3.28}{4.98}$ = 66% 而已.但電力雖少用三分之一,而電流則反加一倍,因若用 100 V. 之泡,點足 4.98 KW., 不過49.8安培,今用低壓泡之電流爲: $I_1=\frac{P}{E_1}=\frac{3280}{34.8}=94.4$ 安培, 實約一倍也.可證低壓泡之爲害於電廠.

由上各項計算,可得一種結果:

(一) 電廠發動機現僅現至 55—60%, 並未超過原定機力. (二) 電廠電流現至 150%, 而用戶用低壓燈泡需一倍之電流,故若用戶改用高壓燈泡,可使電廠電流減少一半,卽減至75%,亦非超過. (三) 電廠電壓力,若用戶全數改用高壓力燈泡後,電流可減少至發電機容最 (Rating) 以內,則電壓可回復至平常(Normal)情形. (四) 用戶需電,現僅得所需量之66%,若用高壓燈泡,可得全量.因用戶用電量自 66%, 加至 100%, 發動機力隨之自55—60%, 增至

90％之譜,亦並不超過容量也.

(三)改良計畫及籌備

全廠內外情形,既已調查清楚,症狀病源,亦已探究無遺,乃謀整理之法,分治標治本兩步.治標之目的,在儘機力供給全市光明之電燈,計可有七千枝25W.燈之數.治本之目的,在無限制供給全市電力,並謀利用電氣發展工業.

治標之法,經商定數項:(一)機器方面儘先修理.(二)變壓器分配三相間,使得平均電力.(三)低壓線先將最腐爛之段修換.(四)電燈公司即行停止裝燈安錶接火.(五)用戶燈泡一律改用 100V. 者.(六)全市燈數限制至七千支,以25W.燈光算.路燈約四五百支在外.(七)包燈制全改爲電錶制,以免浪費電力.

治本之法亦略討論及之,以現在機廠設備,不能併車(Not paralleling)爲一大缺點,不能應付南甯市政發展之需要.且現在廠屋地址亦湫隘,無擴充之餘地,離江頗遠,不能得多量之給水.又以現在所用木炭爲燃料,價格日漲,亦不合大電廠之所宜取,而桂省煤礦尚未發現佳者,故將來燃料方面,究宜用煤,或用木,或用黑油,尚須研究.所以治本計畫,在未決定前必須先調查數事;(一)調查附近煤礦及產量,質地,等.(二)調查沿江適宜建廠之地址,夏秋之季不爲大水所淹者.(三)考察將來電業發展之度量,於三年內可增至若干啟羅華德,於五年內及十年內又可至若干啓羅華德,以定新廠之容量.(四)機器式樣等之採擇.諸如此類問題,均須先有精密之計算.庶可言治本也.是則非一二月之時間不可,因先用治標方法著手,以補救目前之黑暗狀態.

惟雖欲從極小之範圍內謀治標之法,亦不可不略事籌備,以免外界之責難.且商辦公司,自畏勢力薄弱,不敢挺然取締用戶,亦係實情.因由廣西省政府下令組織南甯電燈整理委員會,由省政府,建設廳,公安局,市政籌備處,商

會,邕甯縣署,及電燈公司各舉代表一人,共七人,組織之.此整理委員會,不過藉壯聲勢,以求治標方法之切實執行無阻耳.著者代表省政府,南洋大學電機科畢業陳壽彝君代表建設廳,其餘五代表均非工程人士.

(四)實行改革步驟及效果

實行治標辦法,悉係照所規劃之次序而行.機房機器,督飭修理,惟無試驗儀器,以故機力究竟可至若干馬力,不能確知.一切電表等又多毀壞不準,(因電表之變流器 Current Transformers 多燒壞重做者),惟速度每分鐘轉數則不使其低過5%,蓋若速度低落,電壓亦低,週波(Frequency)照減,而變壓器內之關係極復雜,低壓方面更受影響也.變壓器之分配在三相間,以 K.V.A. ating 容量平均爲標準,此項佈置方法,自不能十分滿意,蓋其容量雖平均,而其實際供電多少,自非試驗及測量其電流不知.有 10 K.V.A. 之變壓器,因所接燈數稀少,祇供給4 K.V.A.之電力,或有 5 K.V.A. 之變壓器,因所接燈數過多,反供給 6 K.V.A. 之電力.此類情形,自屬常見,欲求三相平均電流,須每晚派工量其電流,逐漸排正也.令急切之間,祇得以容量爲標準,分佈三相間,自比以前之祇接二相,成 V字式(Open Delta) 之爲得力也.治標之中,最困難者,爲令用戶改用 100 V. 之燈胆一層.

若廠中添購電機,及引擎一副,有五倍大之電力,則此事亦極容易.蓋開用大機,供給 100 V. 之十足電壓,則各處用戶之低壓泡自然燒去,或不敢用矣.令舊機不能開至五倍電力,所以不能發出 100 V. 之電壓,則惟有逐段處置之一法,先由公司佈告第一號機路線之各用戶,請其即日改用 100 V. 之燈泡,復派員逐戶通告.無如各用戶不睬不理,其理由謂 40 V 之燈泡尚不光明,如何反用 100 V. 之燈泡,則大家將不能見人面矣!無何,第二日清晨,派工先將第一號機路線之各個變壓器高壓方面保險鉛絲拆除,打斷線路,乃於白晝開第一號機.因外面變壓器均拆斷,並無負載,故電壓開至 230 V. 即準同

工人沿該機路線,至第一個變壓器,將該處之高壓保險鉛綫推上,於是該變壓器卽接通電機,其低壓方面卽得115V.一時路燈大放光明,(因路燈無開關,平時隨車開而明車停而熄),各用戶家中之電燈亦無開關,或有開關而永不關者,亦十足光明,一切50V.以下之燈泡,瞬刻卽行燒斷.復督工逐戶檢查,將各燈全數接通,凡 100 V. 以下之燈泡,未燒斷者,概行沒收,給以收據一紙.如此挨戶挨街,至該變壓器所接之用戶檢查完畢爲止.乃將第一個之變壓器高壓鉛絲復拆除,再向前至第二個之變壓器,如法泡製,燒去低壓泡不少,沒收者尤多.白晝開電,實爲南寧所未前見,故各用戶不及預防,後傳說紛紛,闔街知曉,我等後到之處,用戶早已將50V.以下之燈泡卸除.如是,一日間將第一號機之路線肅清,及晚開機,全街通明,電壓十足.尙恐其濫用低壓泡,故入夜復偕工巡視數匝,見有低壓泡則沒收之.市民方面,深怪何以前一晚用100 V. 之燈泡,黑如香光,而是夜乃大放厥明,或有疑廠中添置新機者,或有疑廠中以數機之力,併給一路,而不能恃久者.實不知電燈之黑暗,由於用戶自取之咎也.

第一號機路綫,經整理燒毀及沒收低壓燈泡後,用戶所得之電光,並未限制,比較平時枝數未減,而機廠內之電壓開至2000—2200 V.之數,電流未超過容量之數.從此證明低壓泡之害處,及治標方法之得當.第二日以後逐日整理一段路線,如此共整理六天,而全市大放光明.

全市旣得光明之電燈,勢必需求增加,添多燈支,其結果又必逐漸轉黑,欲於擴充新廠未成立以前,保恃光明之燈,不可不亟謀消極的限制法.乃定三條辦法:(一)停止公司再裝燈安錶接火.(二)包燈制改爲電錶制,惟包燈在三支以下之用戶,爲體恤其無力繳納電錶保證金起見,仍可用包燈制,惟須受嚴格之檢查.(三)全市用戶燈數限定七千支,分配辦法,以三月一日調查用戶裝置燈頭數目爲標準,依照此項數目,平均比例分配.每戶分配得燈數若干,卽發給燈泡印花若干枚.此項印花如郵票大小,刋印號碼,註明華德數,

加蓋整理委員會圖記,貼在該用戶之燈泡上端.以後無印花之燈泡不准點用,違者查出卽行沒收.惟有印花之燈泡,可以隨意移用於居內之各處.此項印花並不收費,至於詳細手續以及取締方法,因太繁瑣不錄,欲詢詳情者可函致該會.此種辦法,不過欲限制各處電燈,同時點用者不超過機房發電量而已,實爲不得已之舉,恐中外各國電廠所鮮見也.

整理時期有數事可堪紀錄:(一)省政府,民政廳,建設廳,公安局等機關,均十分體恤商艱,維護公司,電費一層,向來照章七折付費,此次整理期內,均自行將低壓燈泡更換,軍政機關未有阻撓之事.(二)第一天燒毀低壓燈泡,有數商店,因損失數十元,與公司人員大起爭論,呶呶不休,公司方面以照供電章程須用 100 V. 之燈泡,不准濫用低壓者,日前復發通告,再派員口頭通知,於公司辦事手續,已無缺點,理直氣壯,故各商店亦無可如何.(三)某日至電報局檢查,被拒絕不准入內,該局長復出言不遜,謂電力若足,則自然用100 V. 之燈泡,否則不准除下低壓泡,聲勢凶凶,且將動武.復查到該局偷燈至二倍之多,乃即命將電線截斷止火.不謂是晚該局竟電炬火輝,如同白晝,查係該局人員自行偷接路線.於是又命公司電匠,將該變壓器之高壓鉛線拆下.所有電報局及附近一帶均黑暗.待一小時後,該電報局之電燈復明,乃其自行偷接至前段財政廳之變壓器,此種行爲實屬破壞公用事業.是晚不得已用臨時緊急辦法,將財政廳前之變壓器高電鉛絲亦拆下,殃及前段亦無電火.翌日提出於整理委員會,決付警告,並議罰則,於是該局不敢再自行接電,且在解決之前停止給電.在此種情形之下,必須絕對以強硬態度應付,否則整理無效也.(四)南甯電器店向以販賣低壓燈泡牟利,所存 100 V. 之燈泡有限,自整理後,100 V. 之燈泡大有供不應求之概,居奇昂價,復有以 80 V. 之泡混濫100 V. 以欺主顧者,售者不察.某舖竟以60 V. 之泡,用黑漆塗改爲100 V. 字樣以混售用戶,經查明後將該舖主交崗警帶公安局,除以該項燈泡悉數沒收外,令舖主退還貨款,復以欺詐罪罰銀,識一儆百,以防効尤.

結 論

南甯電燈所以弄至如此之糟,費盡大力始克整頓者,實由於該公司不聘專門工程師以管理之,廠內外毫無計畫,毫無秩序,所用煤氣機復不適宜,無能擴充.用戶用包燈制者多,偷電亦夥,濫用低壓泡,未能及早取締.凡國內小電廠之犯有同樣弊病者,幸早自改良焉.至於南甯軍政界一概照章七折付費,實爲全國之好模範,凡他處營電廠事業者,必須力爭辦到此層,庶於業務不至虧損,以影響於全市之公用,以及交通治安也.南甯電廠治標之法既成功,今正急行磋商治本之法,政府方面,對於公司若能自行擴充,電量供給全市之需要,則已往不咎,並無收回之意,且可展長專利年期,設法指導技術,維持商務,該公司亦憬然覺悟.正在延請工程師,積極辦理焉.

十四年三月十四日著於梧州

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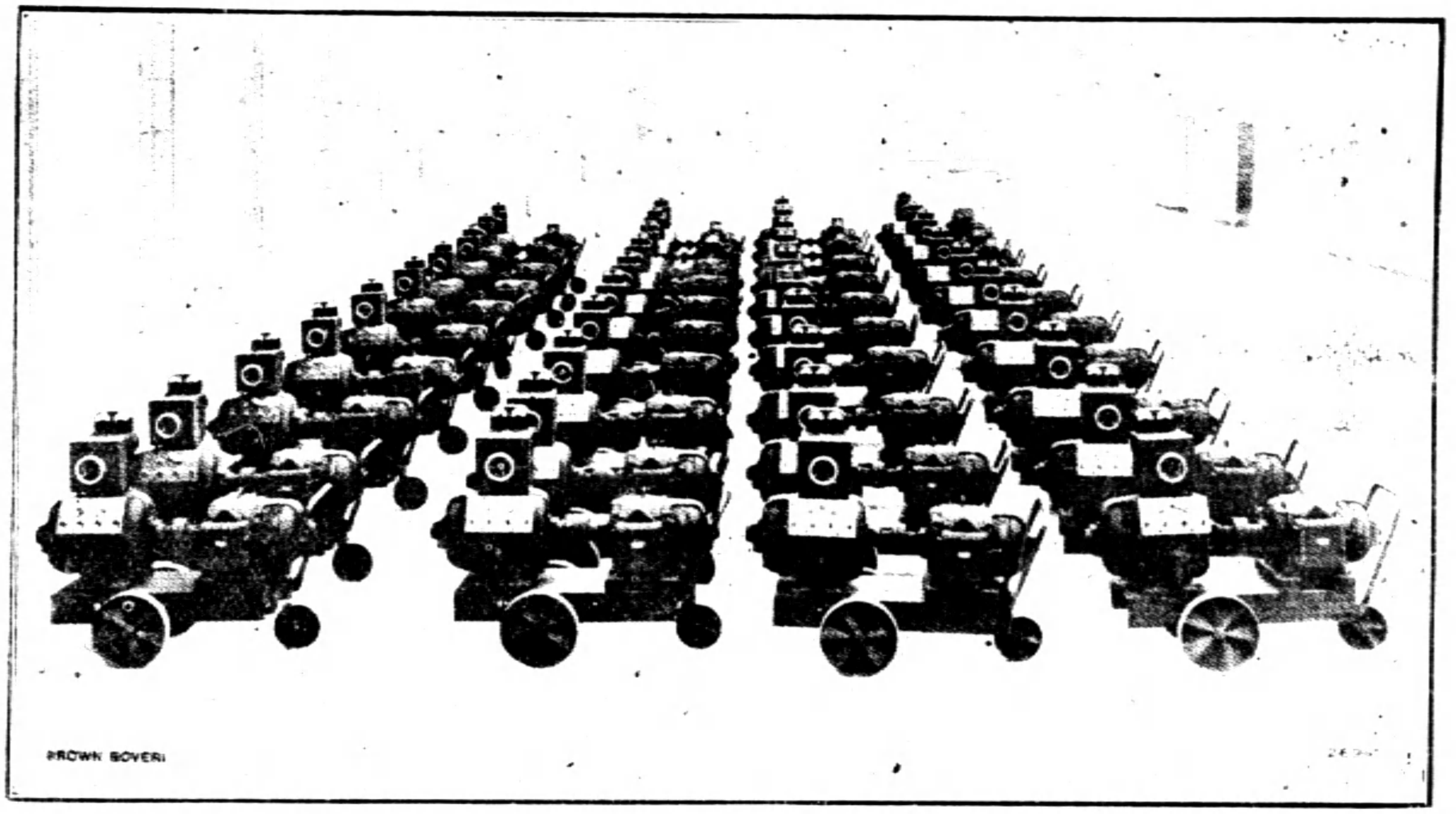

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建造梧州無線電台記

著者：錢鳳章

廣西自統一後，對於省政積極改良而於建設事業尤多擴充．如建全造省長途汽車路，長途電話綫，機車製造廠，士敏土廠，廣西大學等．同時有建造無線電台之舉．數年來成效頗著．茲將梧州電台建築情形分記如下：

天綫鐵塔　廣西桂木，素稱良材，然欲求其高大耐用，適合無線電桿者，非至柳州以上無從採擇．若赴柳採擇運至梧州，俟其乾而用之，則費時耗財，計非所得．至於鉄料尤見稀少，需至港滬方可採辦也．記者乃於九月初旬回滬，購辦材料，招雇工人，迄十月二十日，一切材料，始克完全運梧，開始建造．計鉄塔兩座，各高一百六十英尺，分二十二節，每節長七英尺半．最宜二節各長七英尺，最下一節用四分厚之紅紙板，爲絕緣體，以與地面隔絕．塔之四角，各用拉綫三道，中用鴨蛋形隔電子爲絕緣體．

台址　梧州四面環山，西江中流，撫河側貫，平地殊爲缺乏．故電台地址，祇得於山地覓之．記者經詳細之觀察，始擇定東郊雲蓋山頂爲台址，該山面臨西江，左右清靜，山頂成東北向，利於通達南京．

屋屋　雲蓋山山頂甚狹，因依其勢而作前座樓房，後座平房之房屋．計前座樓下四間爲辦公廳及會客廳，樓上四間爲臥室，後座四間爲機器室電池室收發電報室及報生休息室．

機械　全部機件爲德國德律風根眞空管式，其天綫放電量爲五百瓦特，茲將其主要機件及其作略述如下．

(一) 原動力　七馬力火油機一座，四・五基羅瓦特一百十五伏耳脫直流發電機一座，一〇八安培小時一百二十伏耳脫蓄電池一座，三・五馬力一百十五伏耳脫直流電動機一座，二・五基羅瓦特五百循環二百五十伏

耳脫交電發電機一座.

(二) 電報機　電壓調節器一座,繼電器一座,眞空管式交流改直流器一座,眞空管發報器一座.

(三) 收報機　眞空管收音器一座,二級眞空管擴音器一座,伏耳脫分送器一座.

(四) 無線電話機　受話器一座,擴音器一座,整浪化器一座.

七馬力之火油機用皮帶拖動四·五基羅瓦特之直流發電機,用以過電於一〇八安培小時之蓄電池,此電於發報時送至三·五馬力之直流電動機,直接轉動二·五基羅瓦特交流發電機.此交流電經過電壓調節器分作二百五十伏耳脫及二十五伏耳交流電兩種.二十五伏耳脫者,分送至改流器,及發報器眞空管內之燈絲.二百五十伏耳者送至改流器中之變電壓器,電壓乃增至三千二千或一千伏耳脫,經眞空管之作用改爲高壓直流電,然後送至發報器之眞空管,由此經凝電器及綫圈之作用發生無線電頻度之交流電,然後分送至天線地網散佈於遠方,發報鍵之啓閉乃啟閉改流器中變壓器之原圈也.收報機之作用極爲尋常,即天線所感之電波,經眞空管之作用乃可用聽筒聞之,二級擴音器所以擴大其聲浪也.

無線電話之受話器與普通電話用之受話器同,惟構造較爲精緻,經一度之眞空管擴音器即至眞空管聲浪化器,此合乎聲浪強弱之電流,送至發報器之眞空管內,即將眞空管所生無線電頻度交流電,依聲浪之强弱而增減其振幅,天線所放之電力,因依聲浪之強弱而強弱矣.

梧台名稱爲 XQJ, 所用電浪爲一千五百米突,及九百米突兩種.用一千五百米突時,其天綫放電量爲五安培.用九百米突時,其放電量爲六安培.所及距離日間可達本省各台,及廣東,香港,各台.夜間則通南京,吳淞,杭州,福州,武昌,洛陽,太原,雲南等處,其餘更遠距離,在天氣良好時,亦間能通信.

瑞士卜郎比製造電機廠述略

著者：費福燾

著者於民國十七年冬.由上海新通公司介紹來此.忽已四月.研習之暇.草卜郎比廠沿革及出品情形.簡略敍述.以餉同志.

距今三十八年前.卽西曆一千八百九十一年.白郎君 Dr. Brown 與樸萬里君 Dr. Boveri 組織白郎樸萬里公司.(中譯卜郎比卽 Brown Boveri 之縮音以後簡稱卜郎比)於瑞士之白頓. Baden 其目的係製造應用於電氣上之各種機器.當草創之時.工人不滿七十人.

該廠當初出品.爲發電機.電動機.變壓器三種.以應當時十九世紀末葉之需要.蓋是時瑞士方努力於利用天然水力發電也.

樸萬里君,復於西曆一千八百九十五年.創辦一公司名『動力』Motor. 專門提倡水力發電,以代每年進口無量數煤之流巨.(按瑞士無煤礦)瑞士無數大發電廠.類此得以告成.而卜郎比爲承造電機.因之亦獲許多營業.

瑞士以一彈丸之地.薪工旣貴.且原料缺乏.欲謀營業之發展.非從國外及海外着手不可.故在歐洲各國.及亞美兩洲諸國.均設有經理處.又因列強之提倡國貨.而於外貨課重稅.卜郎比因利乘便.聯合各國之資本家.設分廠於各國.或合併各國固有之電機製造廠爲聯合公司.現今如德法美意等.均有分廠.但分廠均自成其獨立機關.且以各本國之資本占多數.惟遇難題則諮詢總廠.而總廠本其宏富之經驗.專門之人才.供給設計圖樣而於各國製造.總廠.得售設計圖樣及專利之費.在西曆一千九百年.聲譽廣被.卜郎比遂改組爲股份公司.在瑞士之白頓及Munchenstein兩廠.共有雇員(包括工師工人)共五千八百人.在西曆一千九百廿五至廿六年之統計.上述兩廠出品銷路之分配.成下列比例.

瑞士本國	百分之三十五
歐洲各國	百分之四十七
海外各國	百分之十八

卜郎比在其本國營業之大宗.決推瑞士聯省鐵道之電化.

在西曆一千九百廿六年內統計.屬於世界卜郎比公司名下之雇用者有四萬人.

卜郎比最近之製造.關於電氣及機械兩者.分類如后.

(一) 高低電壓之發電機及電動機.

(二) 變壓器.

(三) 電鑰及油開關.

(四) 電氣鐵道上所用之電動機及附屬物.

(五) 拖動柴油引擎及儲蓄電池之特製發電機.

(六) 水銀變流器 (按該器爲最負盛名之一).

(七) 電氣鍛鉄爐及電器鎔鐵爐.

(八) 電銲器.

(九) 蒸汽透平 (按該機營業之佳殆冠全球).

(十) 高壓離心壓氣機及抽氣機.

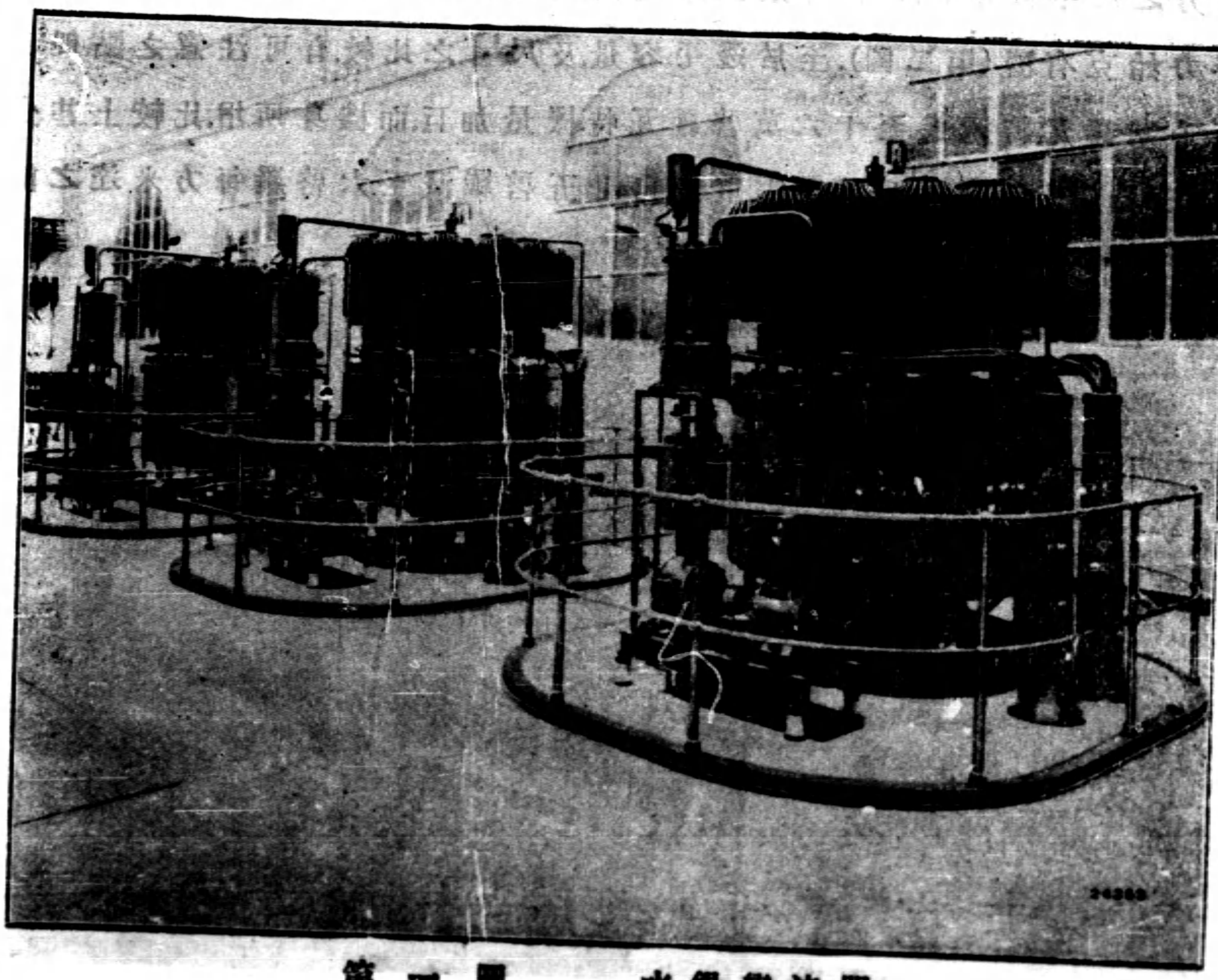
茲將以上主要出品之功用及進步略述之以畢吾文.

(一) 發電機及電動機.應用於大小工業.大小電廠.及電氣鐵道上.在瑞士及其他富有天然水力諸國.其電機之慢速度一種.務適合於水力透平.其快速度一種.則爲其他各項工業之用.

(二) 變壓器.最近趨重高壓傳送電力.幾日增月盛.故變壓器亦與潮流同趨.憶卜郎比前年爲瑞士聯省鉄道造巨大方棚三口.其每只容量爲三萬五千開維愛.包括油重共壹百十五噸.目下已製成之最大方棚.其容量爲四萬開維愛.其電壓高至二十二萬伏而永.

(三) 關於電鑰及油開關.用作聯合線路.及數電廠之鎖鑰.於製造上及尺寸上在今日已不生問題.該廠在西曆一九二五年.爲美國亞海亞煤電公司.承造高度十七英呎半之油開關.其電壓爲十五萬伏而次.試驗時能承受破壞電量至七十二萬五千開維愛.而仍完好如初.卜郎比廠現今製造二十六英呎高度.二十二萬伏而次電壓之油開關.供給意大利某大電廠之用.

(四) 水銀變流器.卜郎比有一特長之出品.即承造巨量之水銀變流器.方其致力研究.適在歐戰之時.列强角逐.無暇及於科學.迨卜郎比完成製造.應用滿意.遂引起他廠之注意.現今德美各大廠.均有製造水銀變流器者.但不能與卜郎比抗衡.按該器之原理.無非利用水銀化氣.作爲交流電變直流電之奐.換言之.卽水銀化氣後.有一特性.能將交流電通過時變爲直流.後者於

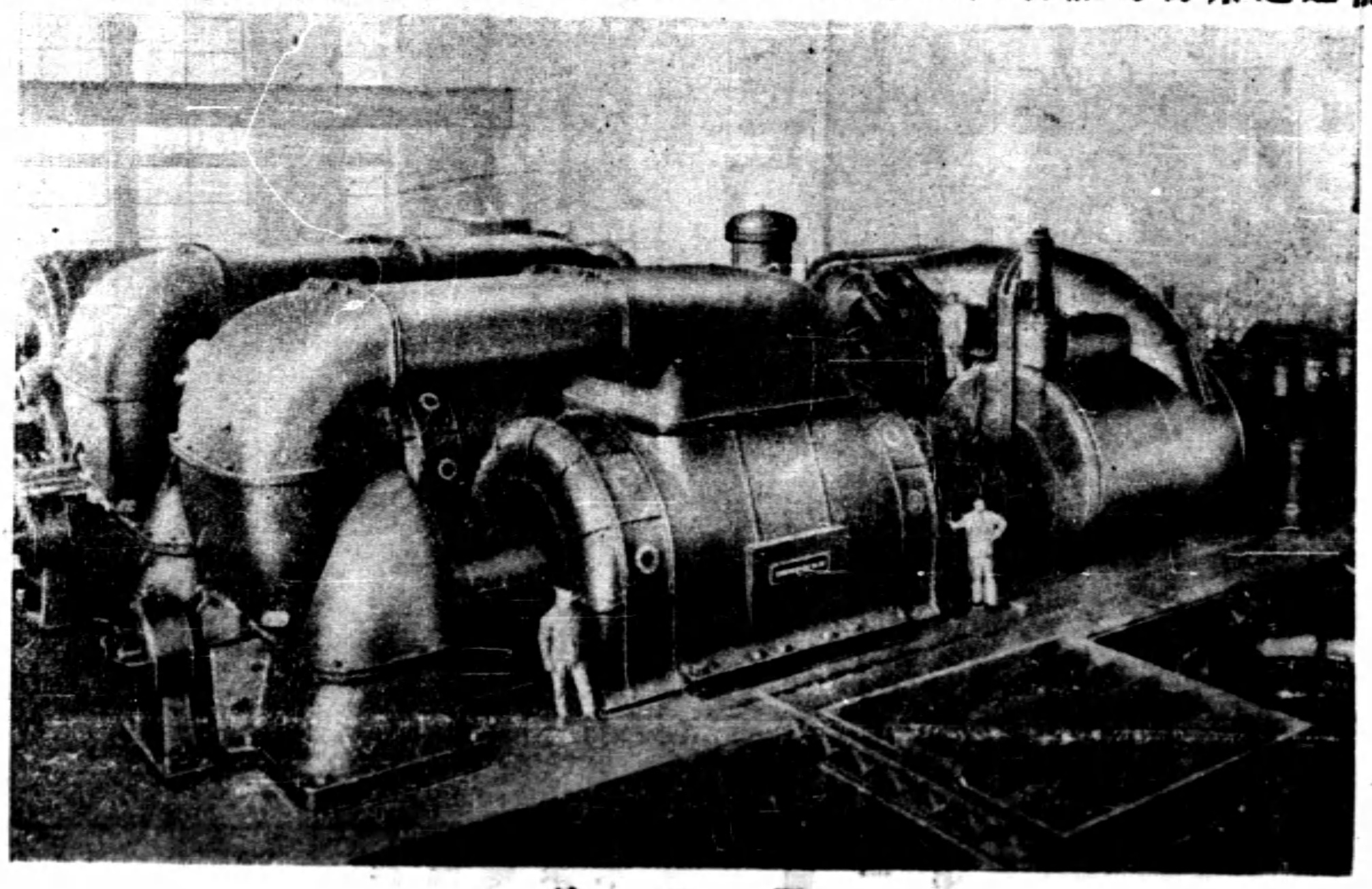


第一圖　水銀變流器

電氣鐵道上.應用甚大.因直流電馬達.啟閉便利.司速自如.且水銀變流器.能負直流電高壓自三千伏而次至五千伏而次.且能載過量之負荷.作者游法京巴黎時.參觀卜郎比承造之水銀變流器.裝置在巴黎地底鐵道之分站.占地經濟.且行走無聲.於都市尤爲相宜.(第一圖)

(五) 電氣熔爐之製造分兩種. (甲) 用電極之熱以熔鐵或別種金屬物. (乙) 用電阻之熱以鍛鐵者.甲種爐.係用自動水壓調整.至其應用於電值較廉之處可以代平常之煤氣爐.

(六) 蒸汽透平.在西曆一千九百年.透平之製造始告大成.起而代蒸汽引擎.卜郎比實爲製造透平之先進.在西曆一千九百十四年.該廠已造成七千五百馬力之透平發電機.陳列於瑞京白內.推爲當時透平巨擘.在西曆一千九百廿六年.又爲紐約愛迪生電燈公司.承造十六萬啓羅瓦特.約合廿四萬馬力之透平發電機.爲世界最大之電機.倘於古時.須如許能力.必合二百萬苦力始克有濟(第二圖).至於透平容量.及尺寸之比較.有可注意之點.卽自五千基羅瓦特遞進至十六萬啓羅瓦特.機量加巨.而機身所增.比較上甚少.(第三圖).又每啓羅瓦特所需重量.自廿五啓羅減至六啓羅每方米達之能



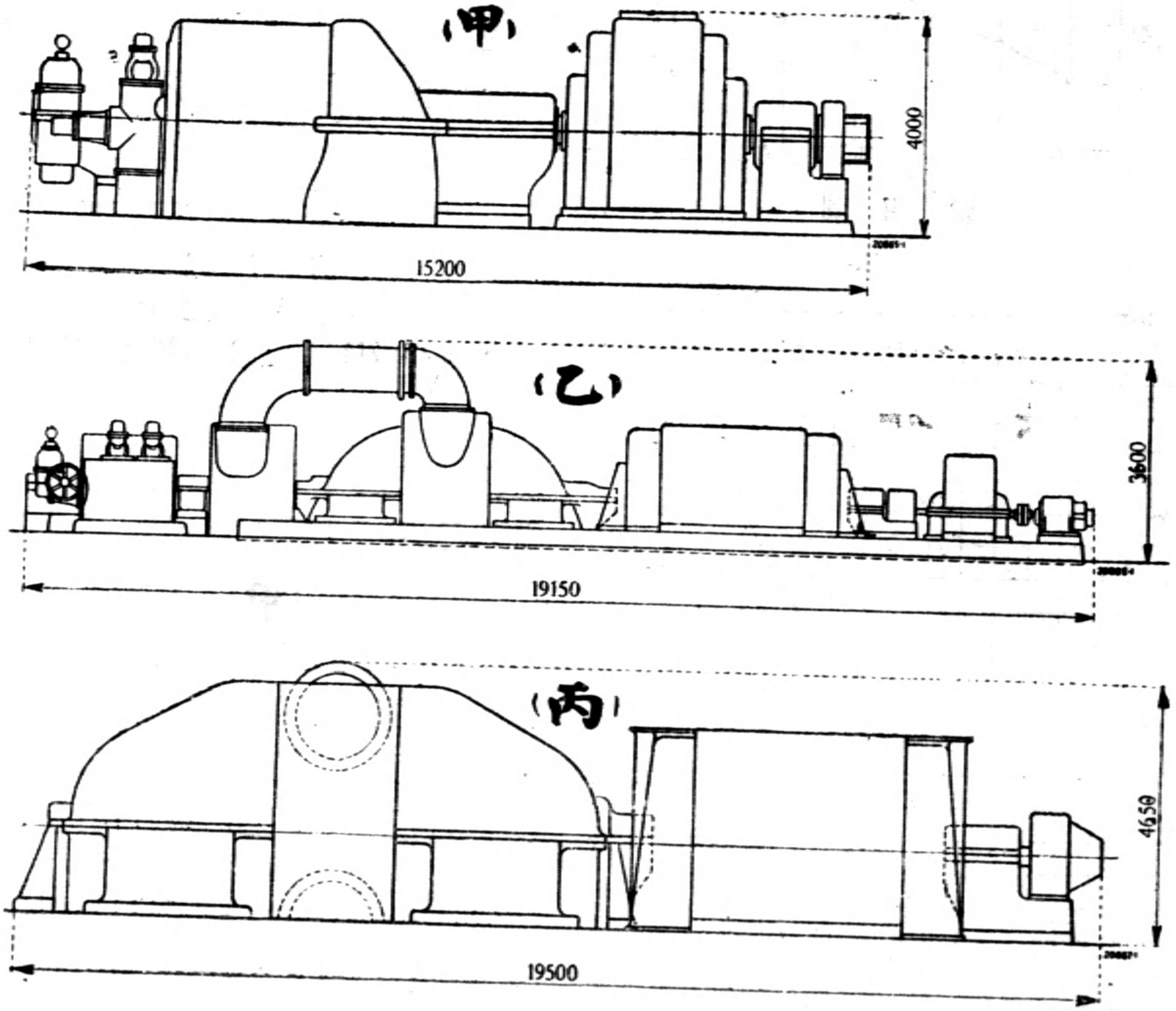
第 二 圖

紐約愛迪生電氣公司之卜郎比十六萬啓羅瓦特透平發電機

力.自一百啓羅瓦特.增至七百啓羅瓦特.可見進步之一班.(第七圖)

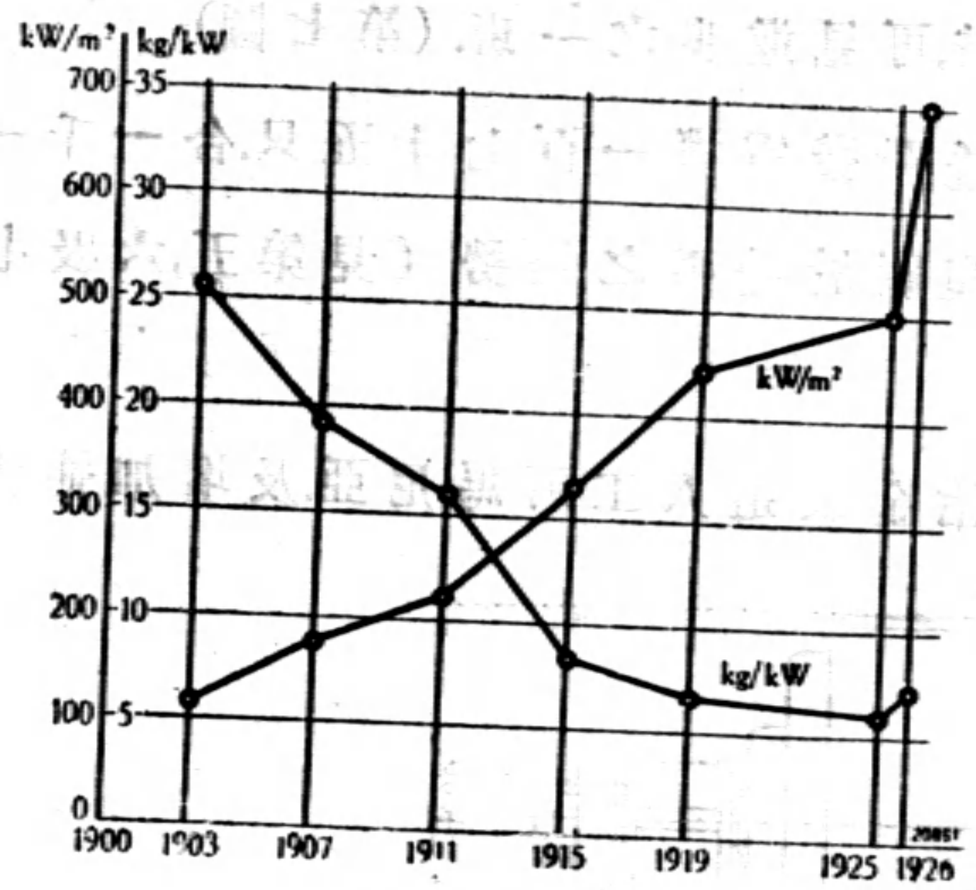
卜郎比廠在西曆一九二八年.銷去透平發電機一百七十五只.合一千一百七十萬基羅瓦特.附圖表四張可略窺關於透平之趨勢(見第五,六及七圖).

(七)離心壓氣機及抽氣機.應用於冶金.製造人工阿馬尼亞.及增加迪士

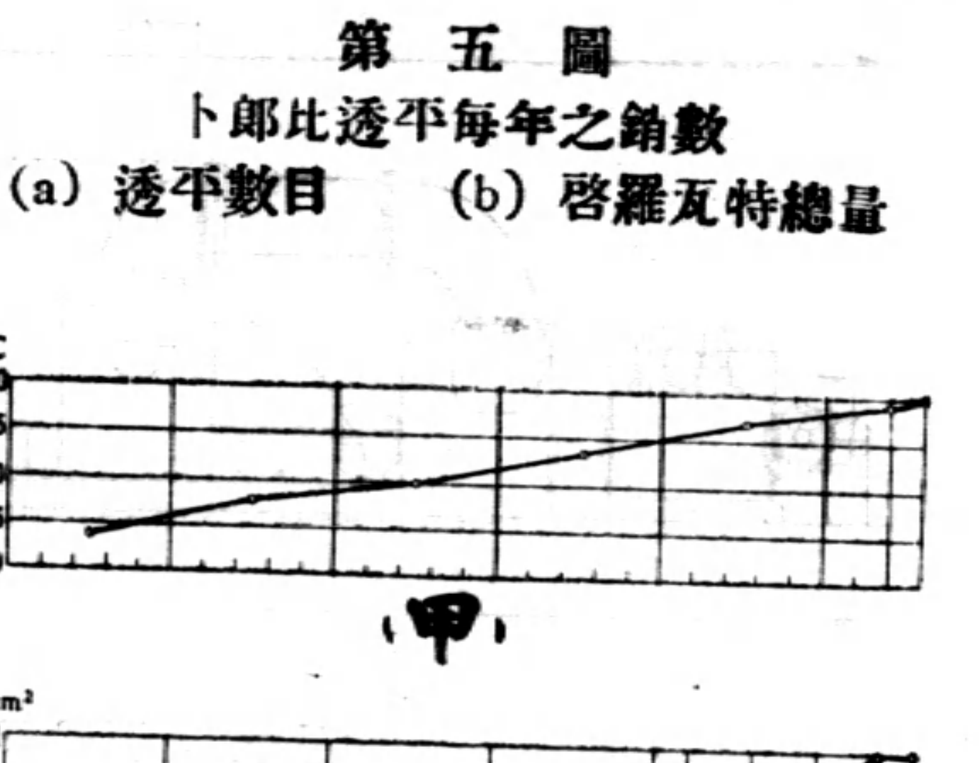


第　三　圖

	一千九百十年		一千九百廿六年		一千九百廿八年
(丙)	10,000 KW 750 RPM	(乙)	20,000 KW 3,000 RPM	(甲)	160,000 KW 1200 & 1800 RPM (2 Shafts)



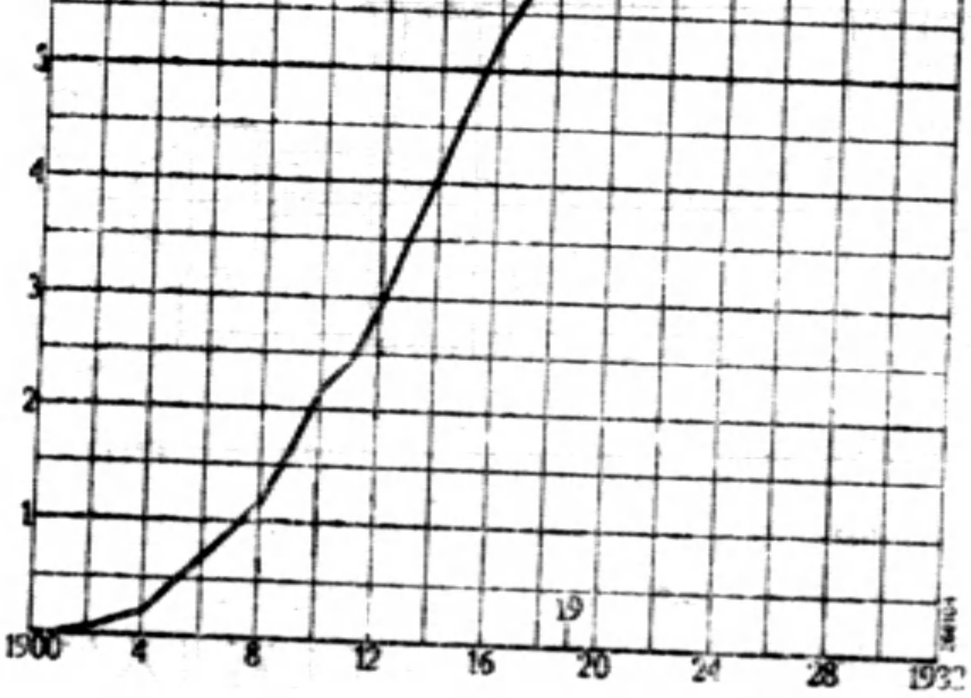
第 四 圖



第 五 圖

卜郎比透平每年之銷數

(a) 透平數目　(b) 啓羅瓦特總量



第 六 圖

透平啓羅瓦特量之逐年遞增

第 七 圖

(甲) 透平溫度之趨勢

(乙) 透平壓力之趨勢

引擎馬力.用空氣運送穀類植物等.均爲實業家所稱道.

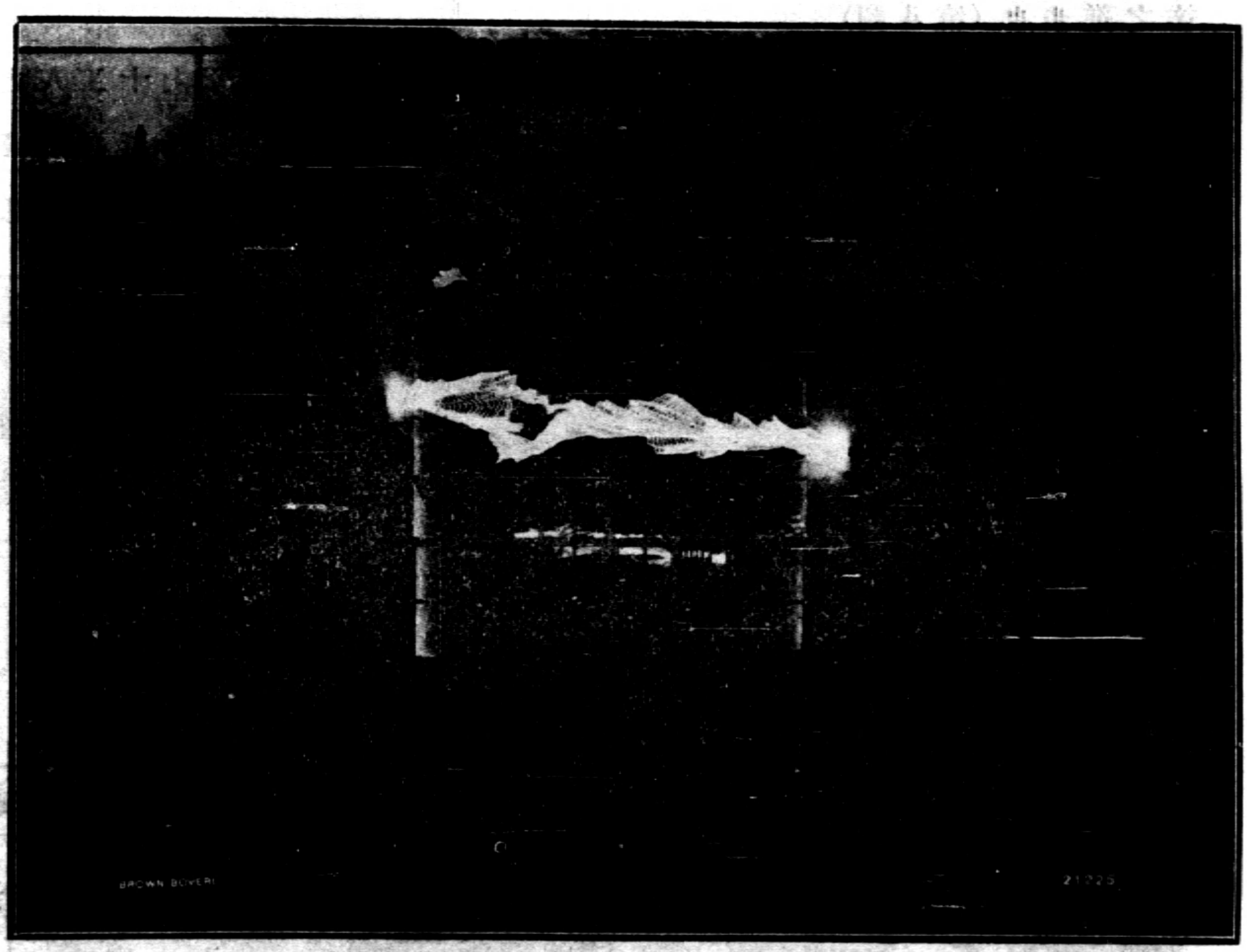
他若普通馬達.每年約造一萬只而強.如三匹馬力一千五百轉之感應馬達.現在重量不過五十啓羅.二十年前同量馬達.約重三倍多.至其價值相差之巨.亦可相推而得.且是項馬達之製造,規模巨大,手續統一,此關於普通馬達之進步也(第八圖).

結論　卜郎比廠以一二人之創造,積數十年之奮鬪,乃能以七十工人之廠遞增至四萬有奇,以儕於世界有名製造廠之一,其間草創艱難,苦心規畫,蓋非一朝一夕之功也.至其訓練技師,延納人雋,俾其計劃得日新月異以應

第八圖

大規模之馬達裝造

世界之潮流.改良工具,精密試驗(第九圖),俾其製造得精優堅固以維社會之信仰.擴充資本,廣播宣傳,庶幾可樹堅撓不拔之基礎以與世界各廠相頡頏.蓋其深謀遠慮,茹苦含辛,又豈易及.則其成功之速之巨,亦良有以焉,願我國人起而圖之.



第九圖
試驗變壓器

BOOK REVIEW

GLYCEROL AND THE GLYCOLS—Production, Properties, and Analyses, by James W. Lawrie, Ph.D. former Chief Chemist of The International Harvester Co., The Pullman Co., German-American Chemical Co., Wm. F. Jobbins Inc., Research Chemist E. I. Du Pont De Memours & Co., and published by The Chemical Catalog Co. Inc. 419-4th Ave. New York City, U. S. A. contains 448 pages and costs U.S. G.$9.50.

This is the first complete and comprehensive treatise published dealing with all the important phases of glycerol and the glycols in one volume. It gives in detail the physical and chemical data with regard to the production, manufacture, qualitatative tests for these compounds as well as other important data gathered during the author's many years of work. Producers and users of glycerols and glycols and their compounds will find this excellent monograph very valuable.

The contents are:

Chapter 13. Nitroglycerol, its manufacture, properties and analysis.
Chapter 14. The Glycols—methods of production, physical and chemical properties, and compounds.
Chapter 15. The future of glycerol.

Reviewed by P. K. B. YOUNG.

INDUSTRIAL CHEMISTRY—an introduction—an elementary treatise for the student and the general reader, by Emil Raymond Riegel Ph.D. Professor of Physical and Industrial Chemistry of the University of Buffalo, and published by The Chemical Catalog Co. Inc. 419 Fourth Ave. New York City, U.S.A.—U.S. G.$9.00.

In a single volume of 650 pages, Dr. Riegel has been eminently successful in picturing and bringing up to the date the constant changes in the numerous commercial activities which make up industrial chemistry.

The book is intended to serve as a class room text in the industrial chemistry course of Colleges, and Technical Schools. The subject are all presented very attractively and the chapters are not too long for single assignment. Most of the chapters have been tested in the classroom. The material for each chapter is carefully balanced and kept within the scope of an elementary treatise, altho there is sufficient specific information on engineering details of practical value to the industrial chemist.

The work is based altogether upon up to date information obtained in the course of professional associaton in plants, by means of visits and interviews, collaboration with experts on specific industries, and a study of the recent patient literature and government documents.

Professors of Industrial Chemistry in Colleges and Technical Schools should consult Dr. Riegel's treatise before deciding on the text book for their next term.

Reviewed by P. K. B. YOUNG.

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徵求無線電界同志合作啓

無線電之效用甚廣,其最著者,厥推通訊,兩地通訊,端賴無線電波,而無線電波之傳播,出沒乎太空,與天時地理等,顯然發生絕大關係,故吾人欲求無線電學造詣精深,計劃確切,對於電波與天時地理等之關係,及大氣中變化之情形等等,非澈底了解不可,顧此又非實地加以試驗不爲功.蓋電波不能脫離太空而傳播,而通訊卽在吾人寄居地球之球面,吾人斷不能縮小地球,作爲模型,以作無線電波傳播之試驗,從事推測太空之情形,攷求無線電波傳播之狀況,有如電機工程,土木工程等之學說,可先假小巧模型,試驗於斗室之中,以盡其推測之能事也.攷地球面積之廣,實地試驗,初不能限於一時一地,必也羣策羣力,各地同時加以研究而後可,年來短波無線電之進步,突飛猛進,英美諸國,進步猶速,攷其故實賴各地一般熱心無線電游藝家之通力合作有以致之,微游藝家,短波之進展,決無有如今日之盛者.雖然吾人今日所具無線電之學識,仍甚幼稚,眞理未發明者尙多.其已發明者,或尙屬錯誤,誠宜急起直追,以冀有所貢獻,豈可人云亦云,僅拾人牙慧而以爲滿足.吾國二年無線電台台數日增,研究斯學者亦日衆,苟能通力合作,實地攷求,對於無線電學前途,或可有多少貢獻,爲科學界放一異彩,則豈獨吾電界之幸,亦國家之光也.爰特擬就收發信機情況,暨收信狀況填註表格式兩種,並附填註說明,作爲初步辦法先行著手進行,如荷吾界同好,賜予贊助,逐項逐日填註,寄交敝人以資研究,曷勝盼禱.表列各式定多不妥之處,並祈加以指正,俾臻完善尤爲欣盼.表後並附問題十數則,至有關係,亦盼指示.竊念研究學術,無分乎國界,遑論國人,還望國內同志,不吝賜教,幸甚盼甚.來件請寄上海尙文門學潔里內三號交鄙人收可也.再鄙人擬將上項填註表付印若干份,備同志填註之用,如荷函索,請聲明份數,定當寄奉不誤.

朱其清啓

(甲)

短波無線電台 收發信機情況填註表

本台呼號＿＿＿＿＿＿

中華民國　　年　　月　　日

電台所在地			電台附近情形	附近障礙物之位置	
地名	經度	緯度		距離	方向

日期	發信機情況																收信機情況				餘言
	振蕩電路電子管			屏極電壓供給法	電波種式	電波		電力	天綫電路與振蕩電路之配合法	天綫最大電流	天綫情形					採用電路	電子管種式		射電週率增音級數	採用電路	
	種式	管數	接法			波長	週波率				種式	方向	高度	長度	天綫長度		增音管	檢波管			

(乙)

短波無線電台 收信狀況填註表

本台呼號＿＿＿＿＿＿

中華民國　　年　　月　　日

氣候／時間	天候	氣壓	溫度
00—6.00			
6—12.00			
12—18.00			
18—24.00			

(一)				(二)					(三)				(四)						(五)	(六)
接收時刻				聽得或與通之電台					被擾亂情形				信號力						紀錄或測驗者	餘言
GMT		當地時刻		台名	呼號	發電時用大約電波		電波種式	電台擾亂		天電擾亂		單式紀錄法	複式紀錄法						
點	分	點	分			波長	週波率		電台呼號	擾亂程度	天電種類	擾亂程度	R	F	R	A	M	E		

填註者＿＿＿＿＿＿

填註說明

(甲)收發信機情況填註表

發信機情況欄

屏極電壓供給法項下: 應請填明係用(一)高壓直流電;(二)低週率交流電;(三)高週率交流電;(四)高週率交流變直流;抑(五)以上各電外加濾電路之電.

電波程式項下: 請註明係爲滿幅波,(Continuous Wave 或 C. W.)斷幅波 Interrupted Continuous Wave 或 I. C. W.)抑爲電話 (Telephone).

電波週波率項下: 填註與否可隨便.

電力項下: 請註明係入電路之電力抑振盪電路或天綫電路之電力.

天綫電路與振盪電路之配合法項下: 應請註明爲感應配合(inductively Coupled) 抑導體配合 (Direct Coupling) 並述其配合之疏密 (Close 或 Loose Coupling).

天綫最大電流項下: 天綫電流表之位置亦請註明.

天綫程式項下: 請聲明爲垂直式抑爲平行式或定向式饋電程式(電流饋電式 (Current feed 抑爲電壓饋電式 Voltage feed) 亦請註明.

採用電路項下: 如能將全部接綫圖附寄最妙.

饋綫長度項下: 除長度外請填明兩綫間之距離,饋綫與天綫交叉形狀.

收信機情況欄

採用電路項下: 如能將全部接綫圖附寄最妙.此外並請聲明所用耳機之程式及何國出品,乙組電池所用之電壓等.

電台所在地之經緯度,如不能填註空白亦可.

電台附近情形項下係指電台附近是否爲平地,抑爲山谷,有無房屋花草樹木以及金屬之物如高大鋼骨建築品等而言.此外如能將地質之潮濕與否,以及有無沙石等項填入更善.

(乙)收信狀況填註表

第一欄GMT項下: GMT係Greenwich Mean Time之縮寫,填註與否可隨便.

第二欄台名項下: 本項如不能填註,儘留空白.

週波率項下: 本項可不必填注.

電波程式項下: 本項應請將滿幅波 (Continuons Wave或C. W.) 斷幅波 (Interrupted Continuous Wave或I. C. W); 或電話註明至音調之或爲低週率交流電Raw A. C. 抑爲純粹直流電Pure D. C., 仰爲高週率交流電H. F. A. C. 如能填明亦請填入.

第三欄擾亂程度項下: 指正式接聽之信號,是否尙能接收而言.

天電種類項下: 天電計分急響 (Grinders或Rattling); 嘶音 (Hissing); 啪嗒聲 (Cliches或Snapping); 及碎裂聲 (Crasting).

(註) 嘶音類類英文字母S拖長之聲,又如狹孔出氣之聲.

急響酷類將碎石一掏向玻璃窗擲去所發之聲.

啪嗒聲爲一種低微尖銳之聲,頗似表中發生之啪嗒聲,惟忽斷忽續,久暫無定.

碎裂聲爲破碎之聲,頗與啪嗒聲之天電相同,惟發現時作聲較久較連續,且較多耳.

第四欄信號力項下: 分單式與復式兩種均係表示信號力之強弱者,單式週錄法以前通行採用RI至R9現在已改用新法係自RI至R5其程度如下.

R1 = Hardly Perceptible; Unreadable
R2 = Weak; readable now and then
R3 = Fairly good; readabel, bnt With difficulty
R4 = Good; readable.
R5 = Very Good; Perfectly Readable.

複式紀錄法係美國無線電聯合社所規定,其紀錄法如下,如能填註,請儘量填入,否則,留空白亦可.

F—FREQUENCY

F 1 Violent fluctuations to outside audible range
F 2 Violent fluctuations within audible range
F 3 Sharp changes in sudden jumps
F 4 Swinging over range of 200 or 300 cycles
F 5 Changing considerably with keying
F 6 Slowly drifting
F 7 Changing slightly on dashes
F 8 Very slight variations
F 9 Variation too small to detect

R—RELATIVE STRENGTH

R 1 Very weak, unreadable and intermittent
R 2 Very weak, unreadable
R 3 Weak and still unreadable
R 4 Weak but of readable strength
R 5 Fair signal of readable strength
R 6 Good signal of readable strength
R 7 Strong signals
R 8 Commercially strong signals
R 9 Very strong commercial signals

A—AMPLITUDE VARIATIONS (FADING)

A 1 Violent rapid and slow fading to inaudible
A 2 Violent rapid fading, mutilates characters
A 3 Violent slow fading, drops whole letters
A 4 Very rapid fading, modulates signal note
A 5 Moderate rapid and slow fading, few mutilations
A 6 Moderate rapid fading but rarely inaudible
A 7 Moderate slow fading but rarely inaudible
A 8 Fading detectable but not troublesome
A 9 No detectable variation in intensity

M—MUSICALITY OF NOTE

M 1 Extremely rough hissing note, no trace of musicality
M 2 Very rough low note, slight trace of musicality
M 3 Very rough hissing note, slightly musical
M 4 Rough note, moderately musical
M 5 Rather rough but musical note
M 6 Slightly hissing musical note
M 7 Musically modulated note
M 8 Smooth clear note, very slightly modulated
M 9 Pure C. W. note, clear and musical

E—ESTIMATED COMMERICAL READABILITY

E 1 Just able to distinguish signals
E 2 Able to distinguish a few familiar words
E 3 Plain language 10 wpm double, code unreadable
E 4 Plain language 15 wpm double, code 10 wpm double
E 5 Plain language 15 wpm single, code 20 double
E 6 Plain language 25 wpm single, code 18 wpm single
E 7 Code or plain readable 25 wpm
E 8 Code or plain readable 35 wpm
E 9 Code or plain readable at highspeed

氣候時間欄　天候項下: 將請風雨雷雪雲霧等等填入.

氣壓項下: 如無氣壓表可不填註.

問題十二則

(一) 每年中何月何日或何時接收某某數台最爲清晰?或某某電台之信號完全不能接收?各該台所用之電波波長各約爲若干?

(二) 一年中尊意何月何日何時天電最少?何時天電最多?

(三) 每年中大約何種波長之電波能接收之時間最久?

(四) 以閣下之經驗,氣候與通信上有何等之關係?

(五) 白日與夜間,夏春與秋冬,射於短波通信上,有何種特殊之現象?

(六) 短波嘗有回波(echo)現象,回波云者,即於某時接得之某一信號在數秒或數分之一秒後復能接得之謂,閣下亦曾遇見此種回波之現象否?

(七) 何種電台,曾發現回波之現象?其波長爲若干?其復現之時間約若干?

(八) 短波音衰(Fading)之現象頗烈,尊處亦嘗發見之否?一年中何時最多?其電台爲何名?所用波長爲若干?

(九) 各電台間有無互相擾亂情事?其擾亂性質如何?其擾亂之程度又如何?所用波長相差若干?容電器(Candenser)上約有若干分度(Degrees)?

(十一) 該容電器之容電量爲若干mmf?或該容電器有若干片?除發射電台發出之電波互相擾亂外,尚有他種之擾亂否,如電梯之升降,引擎之開動,汽車之往來等此類擾亂多否?擾亂程度如何?

(十一) 國內電台尚無用晶體按制之設備者,故電機發出之電波其週率難免無變動之弊,對於接收上自感困難,請問其變動程度如何?接收機之容電器上約有若干分度?該容電器之容電量爲若干?或該容電器有若干片?

(十二) 傳發電台之電扣(Key), 有時發生火花,接收之電台,亦曾有信號之點畫接收不能清晰,而加質問者否?

本刊工程四卷論文總目

(一) 土木工程項

(二) 機械工程項

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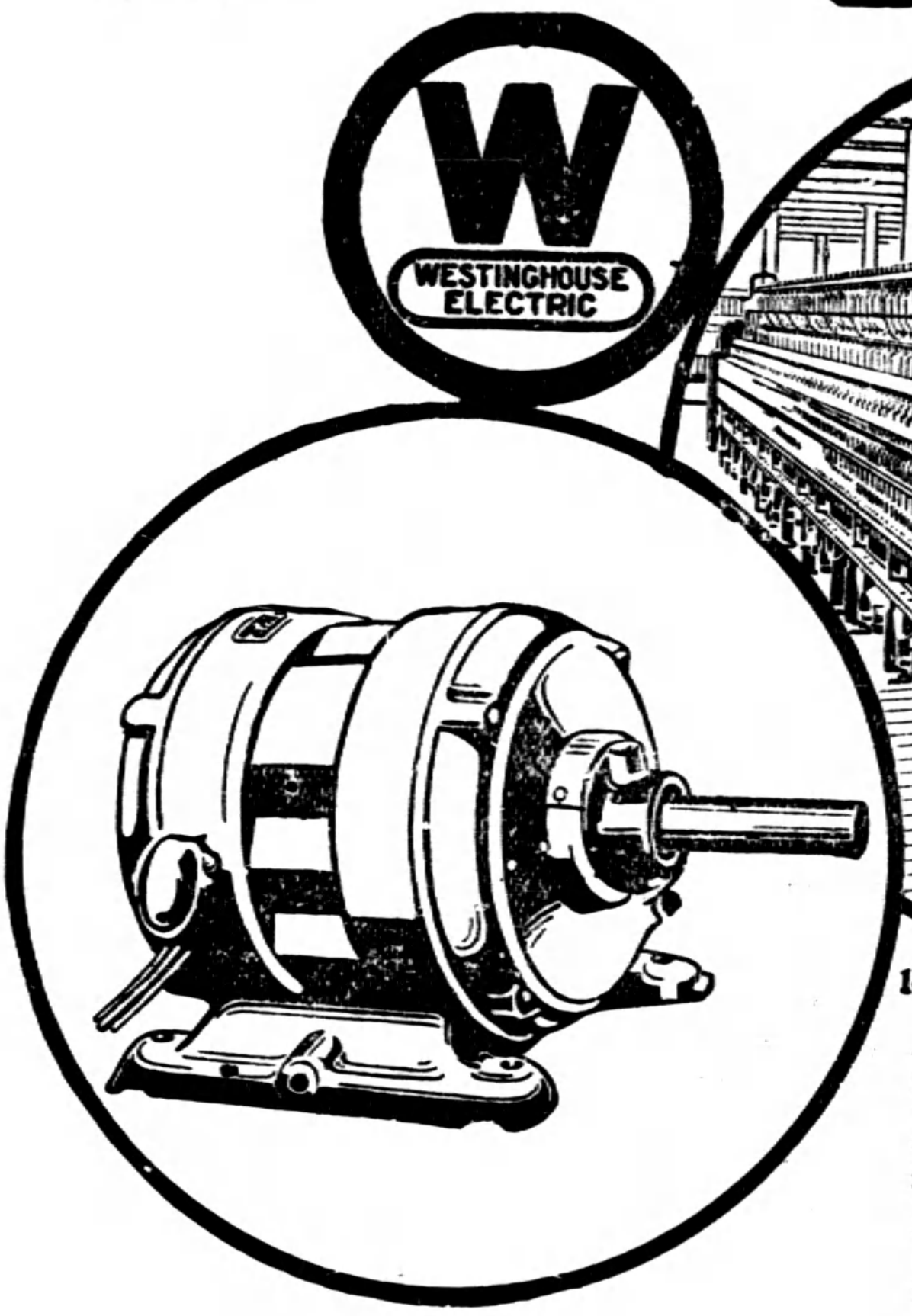

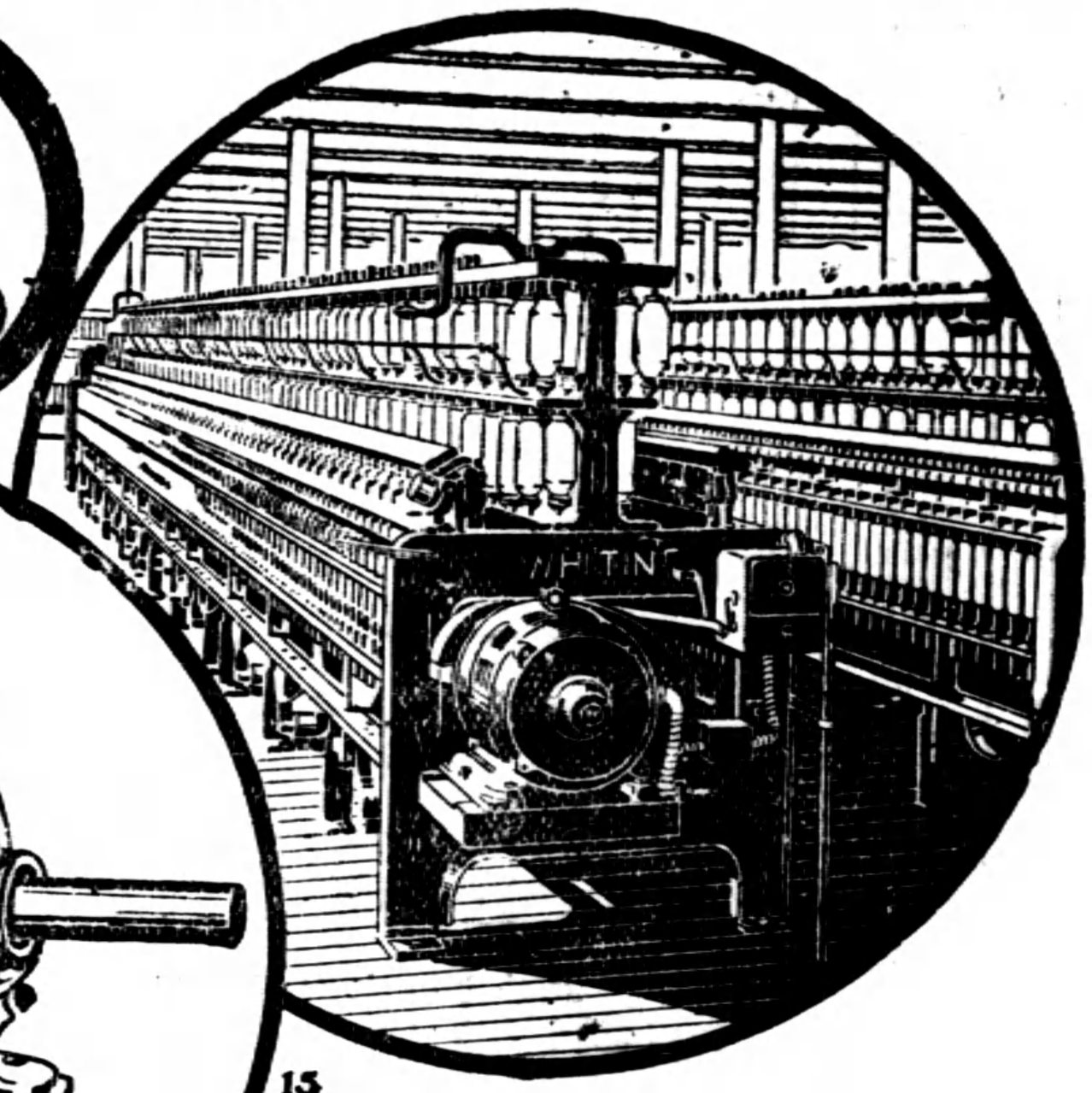

15

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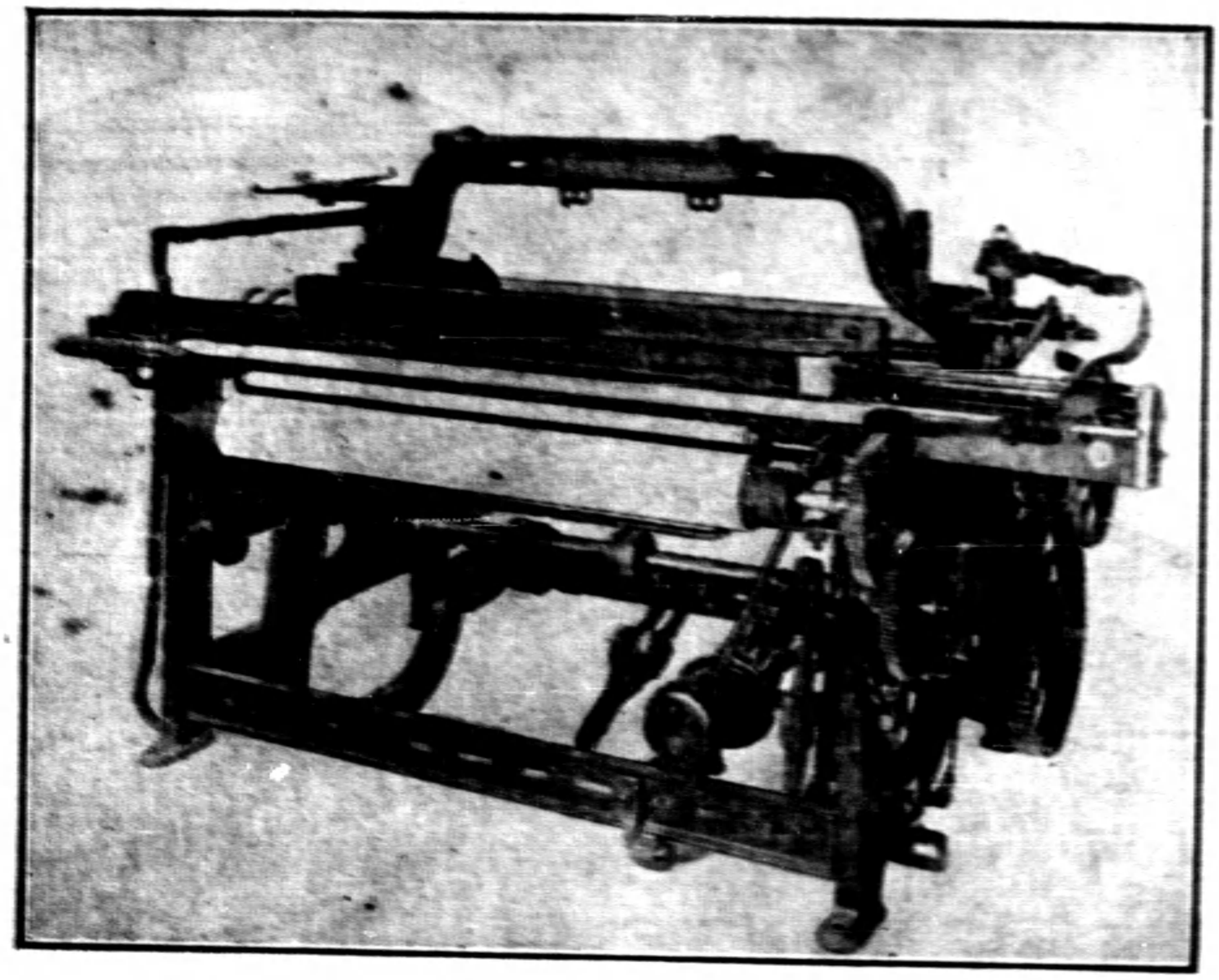
茂和公司經理

請聲明由中國工程學會『工程』介紹

上海大隆鐵廠新出品之一

製造廠 上海戈登路底浜北 電話閘北六十九號



樣子間 上海江西路二一九八六四號

新式織布機

機架用特種合鋼（STEEL）鑄成一切緻件均用鋼模（MOLD）係精極的用牙輪搭連紗軸（GEAR DRIVEN）鋼鑄放式樣一致尺寸準確

本機送經裝置（LET-OFF MOTION）係精極的用牙輪搭連紗軸（GEAR DRIVEN）漸漸展放有複整機關使展放程度依照經紗上所受張力常保平衡面減少斷頭

紗軸初上車時其對徑爲十八吋兩用漸小至經紗用完時對徑僅及四寸有餘於經紗所受張力驟徑上項調準裝置面背未能至理想中之平衡本機因此添裝另一機關以弭上項缺憾

本機除梭箱捲布楗打梭棒等必須本製以求運動輕靈外餘件均用鋼鑄製成機身特別加重所以堅固耐用

本機機架組合處均經機器車制故能十分密接絕無震蕩搖動之弊其關節活動處均有電制襯墊故能經久靈活

本機潤軸係用特別機器潤製潤面係精圓形故能勝受高速度各種軸心係用一種冷軋鋼（COLD DRAWN STEEL）造成能任受劇烈之磨擦面不易損蝕梭箱木料均經水汀（STEAM）蒸過永無乾縮變形之弊

本機設有游壺裝置（LOOSE REED）倘遇打梭不佳梭子中途停頓時有此裝置可免軋壞織品

本機設有斷緯關車裝置（FILLING STOP MOTION）倘遇打梭不佳梭子中途停頓時或梭子用完時機自動停車

本機捲布刺毛軸係完全鐵製外包有刺鋼皮不比他種布機之用木軸易致彎曲

本機機件無論大小均有號碼將來損壞添配時但舉該件號碼本廠立能供應保能適合

本屆西湖博覽會工業館內
有本廠布機兩部陳列請海
內紡織家機械家批評指教

諸發明由中國工程學會「工程」介紹

中華三極銳電公司
The Chinese Triode Electric Co.

標商

本公司創辦有年，設備完美，技藝精良，出品迅速，所製各項長短波無線電報電話收發機等，簡便合用，價廉物美，爲國產之上乘，茲將各項出品列下：

◉短波無線電發報機　現製有三千華特，五百華特，二百五十華特，一百華特，五十華特等各式無線電機，效率宏大，通訊便利。

◉長短波兩用無線電發報機　有一百華特，二百五十華特等現貨，電波憑定，接聽便利，用於船上，尤爲合宜。

◉軍用無線電報電話機　有五十華特及十五華特等軍用機，以備採購，提攜輕捷，行軍利器。

◉長短波兩用無線電收報機　有三座眞空管長短波收報機及三座眞空管收音機，接音清晰，絕無噪聲。

◉短波波長計　刻度準確，堅固耐用。

◉無線電機另件　如變量空氣電容器，感應線圈，快報機，電鍵，眞空管座子等，無不加工製造，式樣美麗，定價低廉，較舶來品有過之無不及。

本公司除自製各項機件外，承造大小無線電台，計劃無線電播音機，修理各國無線電機并經售各種無線電機另件如蒙各界賜顧，無任歡迎。

▲附註　敝公司備有無線電機出品目錄一冊印刷精緻奉贈交通界同人如荷函索即當寄奉。非交通界同人每本售大洋二角

事務所：上海霞飛路一三七九號（福開森路口）　電話　三三八九七號

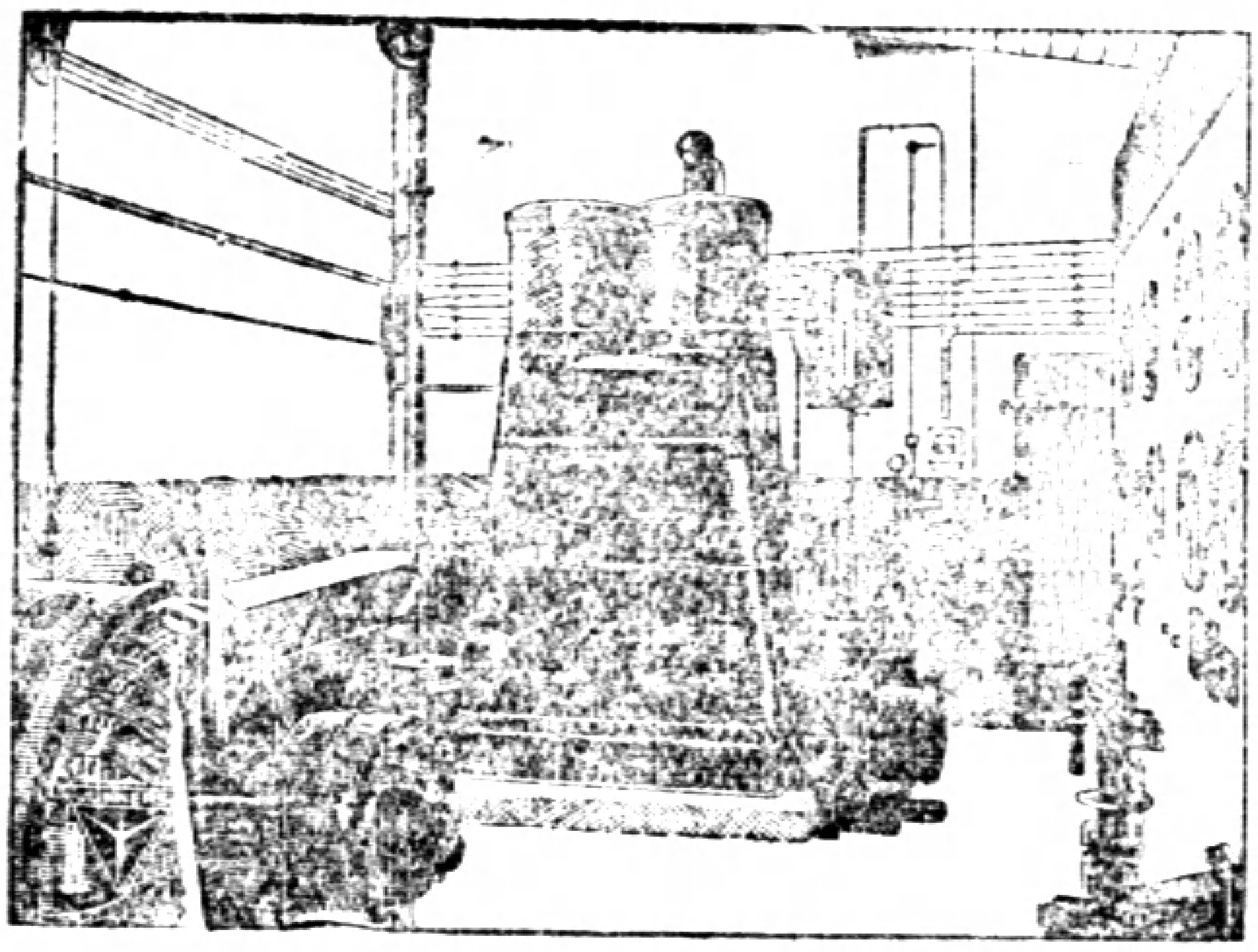
製造廠：上海汶林路六〇號至六六號

德國永固廠出品

雙配司登柴油引擎

JUNKERS DOUBLE PISTON DIESEL ENGINE

不用凡耳
無汽缸頭
冷氣開車
輕便堅固
用油甚省
毫無震動
佔地甚小
管理簡捷
裝置迅易



Without Valve
Without Cylinder Head
Starting with Compressed Air
Light and Compact
Low Fuel Consumption
Entirely Vibrationless
Occupies Small Space
Easy Control
Easy Erection

中國獨家經理

孔士洋行

SOLE AGENTS: KUNST & ALBERS

機器部設四川路二十九號七樓

樣子間設圓明園路一號

商務印書館出版

實業及工程學書

實業叢書

中國之紡織業及其組織

周培蘭譯　一冊　定價一元二角

書譯日本井村薰雄原著，內容共分五章。前兩章詳述中國進口紗布之盛衰，國內紗廠業之發展，中日紗廠之競爭與各埠紗布分配之概狀，繼敘及日本國內棉業情形與其政府所採之改良計畫。第三章關於中國棉花之產銷，印美埃三國棉質之比較及使用印棉之得失，皆詳細指述。第四章對於紡織界勞工運動之趨勢與解決勞資爭議所應持之方針，一一加以說明。第五章論中國關稅政策與紡織業之關係及其將來。全書偏重實際，包羅甚富。

學藝叢刊

石油與石炭

中華學藝社編　石油爲交通及國防器具之原動力，在工業上佔有極重要之地位。本書共分八篇：前五篇專述石油；後三篇則述石炭。如石油問題、頁岩工業、石油在國防上及產業上之眞價值、我國新疆油礦與世界石油問題、石炭之低溫乾餾等，均極詳盡。

一冊　定價六角

工程叢書

河道工程學

劉友惠編　河道工程爲水利工程的一部，包括改良航路及防禦水患的工事。本書用淺顯的文字，說明一切原理與方法，不僅可供從事河工者之研究，兼爲一般關心水利者所當瀏覽。書分五編：第一編總論，第二編高水河工，第三編低水河工，第四編河口修治工，第五編渠。插圖一百廿二幅。

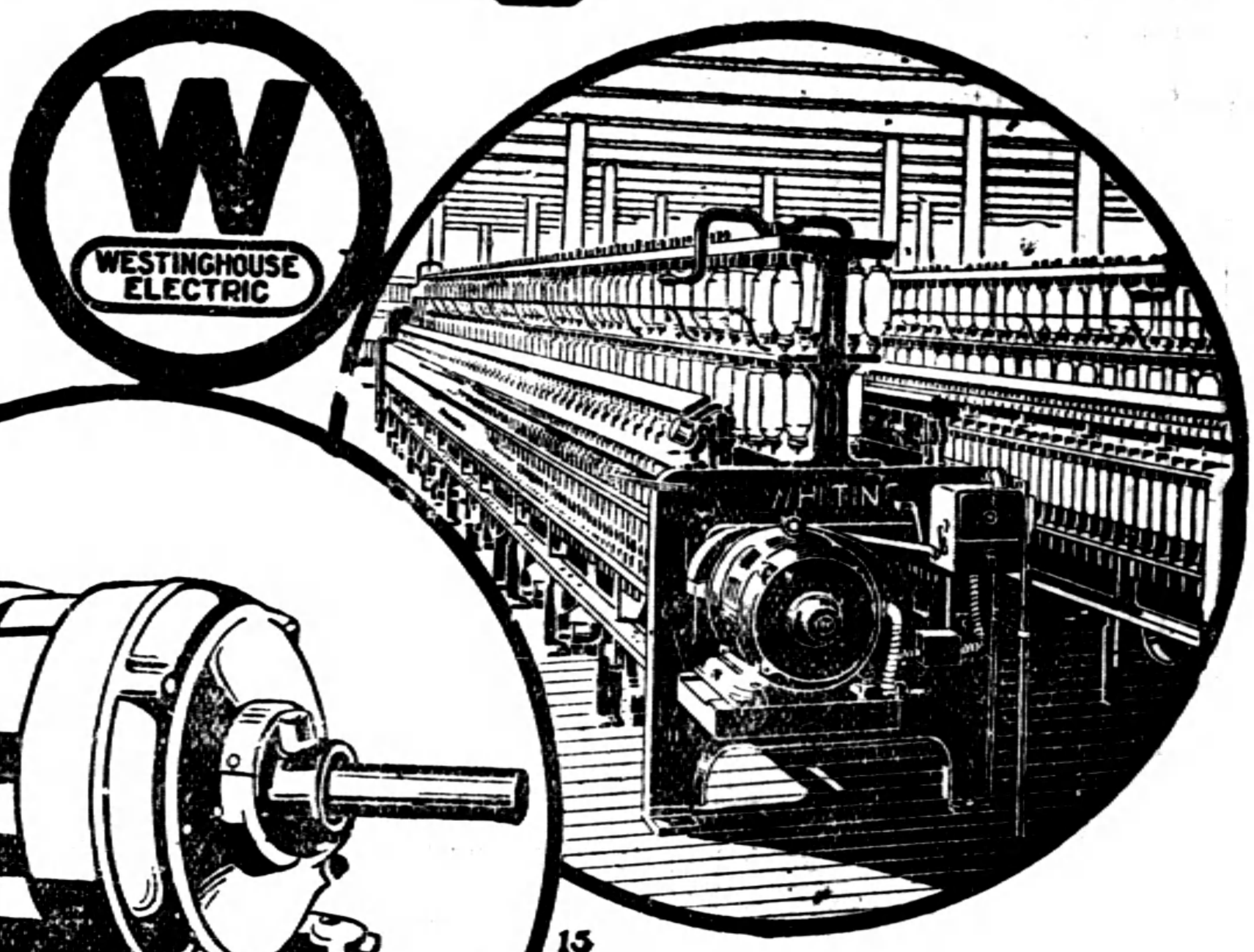
一冊　定價一元二角

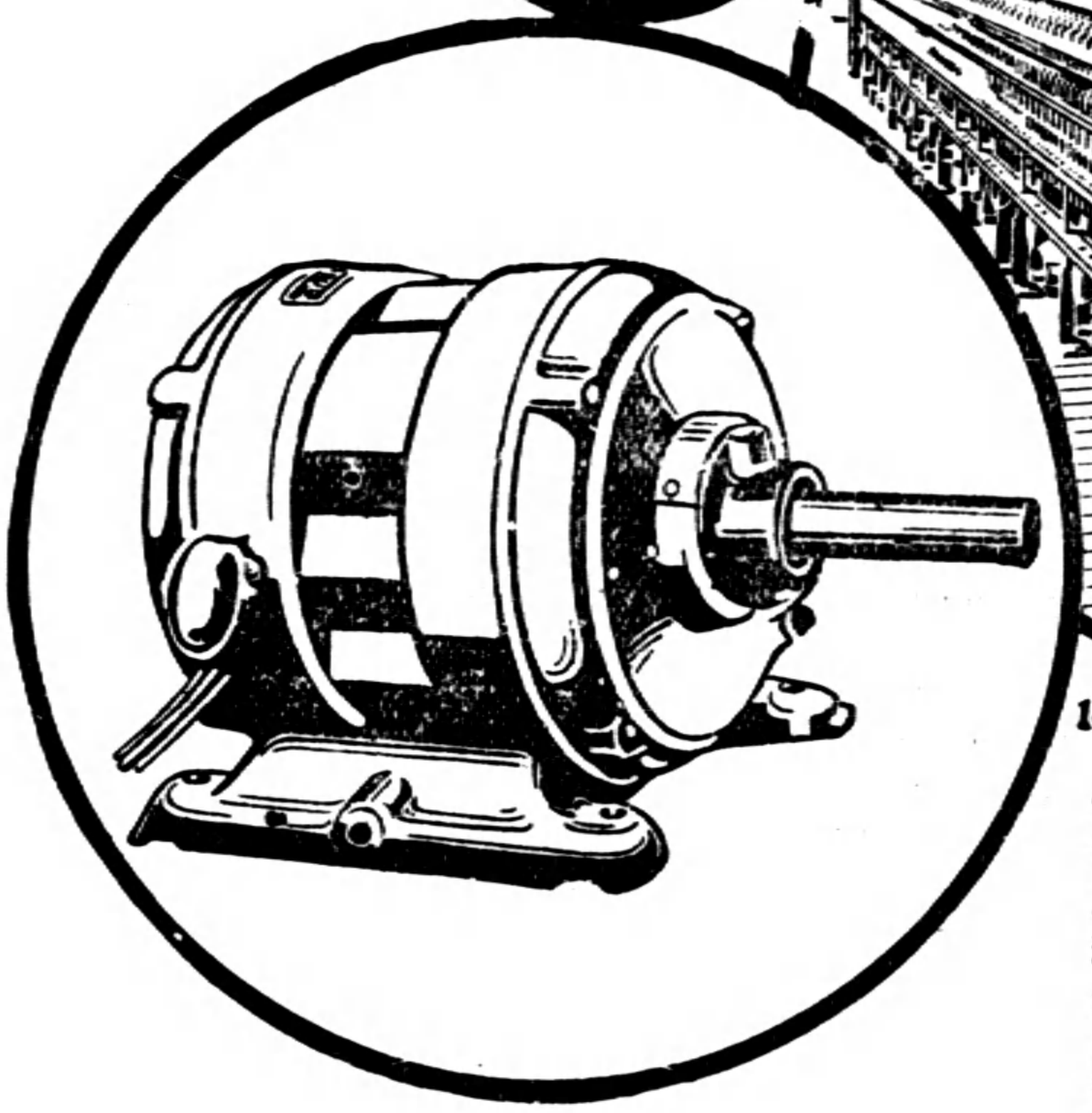
汽車運輸學

美國 P. White 著　蔣鳳五譯　書分二十章，分述汽車運輸上各項問題；對於工程之與經濟有關係者，亦詳論無遺，原書材料偏重美國情形，此書酌量刪去，復參合國內情形，加入汽車法規等數章，益覺適用。

一冊　定價八角

Westinghouse





13

用單獨馬達轉動紡織機有四大特點

(一)增加產量——每機可單獨開停不致牽動他機
(二)節省經費——不用皮帶
(三)出品精美——廠內空爽光線充足不易揚塵
(四)裝置安全——減少振動建築耐久

選擇紡織機應用馬達有四要點

(一)馬達外部必需具相當設備以防棉塵侵入
(二)馬達需用特別隔電物以防潮濕
(三)馬達西軸必需全封以棉塵侵入而致漏油
(四)馬達最高熱度必需以攝氏四十度爲標準以防發熱

美國威斯汀好司製造之馬達富紡織廠應用之馬達有經驗能符合以上條件凡經營紡織事業者均請留意

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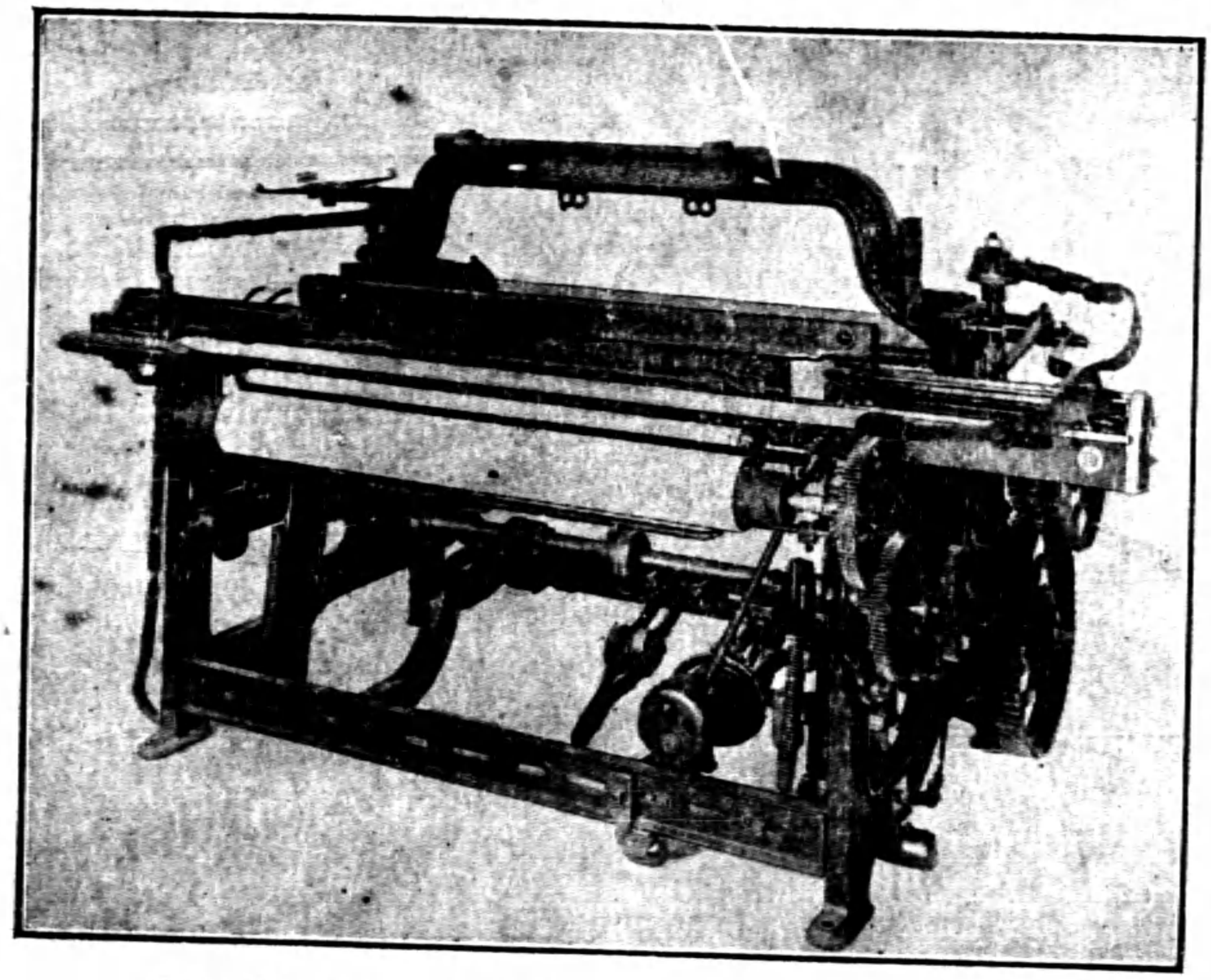

樣子間 上海江西路二號電話一九八六四

新式織布機

機架用特種合鋼（SEMI—STEEL）鑄成一切鐵件均用鋼模（METAL PATTERN）翻鑄故式樣一致尺寸準確

本機送經裝置（LETTING-OFF MOTION）係積極的用牙輪搭連紗軸（WARP BEAM）漸漸展放有複雜機關使展放程度依照經紗上所受張力（TENSION）而自動調準即張力高即多放張力低則少放務使所受張力常保平衡而減少斷頭

紗軸初上車時其對徑爲十八吋漸用漸小至經紗用完時對徑僅及四寸有餘故經紗所受張力雖經上項調準裝置而尙未能至理想中之平衡本機因此添裝另一機關以弭上項缺憾

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本機瀉油軸係用特別機器瀉製瀉頭斷面係橢圓形故能勝受高速度各種軸心係用一種冷輾鋼（COOL DRAWN STEEL）造成能仟受劇烈之磨擦而不易損蝕梭箱木料均經水汀（STEAM）蒸過永無收縮變形之弊

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本機機件無論大小均有號碼將來損壞添配時但與該件號碼本廠立能供應保能適合

本屆西湖博覽會工業館內有本廠布機兩部陳列請海內紡織家機械家批評指教